CIVIL ENGINEERING

MAY 2 1933

Published by the
American Society of Civil Engineers

McClintic-Marshall Corporation

Erecting the Lift Span of the Albany-Rensselaer Bridge Across the Hudson River

Volume 3 Number 5

MAY 1933

Simplify the matter of
ENDURING DRAINAGE

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Among Our Writers

Shortridge Hardesty became associated with J. A. L. Waddell in the design and construction of bridges in 1908, and since 1927 has been a partner in the firm. Many important bridges have been designed and built by this firm.

Edward P. Lupfer began his professional career in 1895, working on railroad location and construction in the West for the Denver and Rio Grande Western Railway and the Great Northern Railway. After serving the New York Central and the Buffalo and Susquehanna Railway, in 1907, he organized a firm of consulting and contracting engineers in Buffalo, N.Y. In 1925 Mr. Lupfer was chief engineer and builder of the Peace Bridge across the Niagara River.

Harland Bartholomew has been engineer of the City Plan Commission of St. Louis since 1916. His private practice has extended throughout this country and into Canada and Latin-America. With his aid, comprehensive city plans and zoning ordinances have been prepared for more than fifty cities. He is the author of *Urban Land Uses*, published last winter.

Dimitri P. Krynine started his engineering career in Russia, where he graduated from the Institute of Ways of Communication at St. Petersburg in 1901. He was Professor of Civil Engineering in the Superior Technical Institute of Moscow for 12 years, during which time he also acted as consulting engineer in different branches of civil engineering. Since 1923 he has been engaged exclusively in soil research. In 1929 he came to this country and became Research Associate in Soil Mechanics at Yale University, which position he still holds.

Robert W. Abbett graduated from the Missouri School of Mines in 1925 with the degree of B.S. in C.E., and received an M.S. in C.E. from Yale in 1932. He has had a varied experience in structural engineering, building construction, and foundations. Since 1929 he has been an instructor in civil engineering at Yale. Recently he accepted an appointment as Assistant Professor of Building Construction on the Thompson Starrett Foundation at Union College, Schenectady.

Herbert D. Vogel, after graduation from West Point in 1924, received the degree of M.S.C.E. from the University of California in 1928 and that of Dr. Ing. from the Technical University of Berlin in 1929. Since that date he has served as Director of the U.S. Waterways Experiment Station at Vicksburg, Miss. He also had charge of the design and construction of the station.

Paul W. Thompson received his commission in 1929 on graduation from West Point. He then served one year in the Kansas City Engineer District and took a postgraduate course at the University of Iowa. In 1932 he became assistant to the director of the U.S. Waterways Experiment Station at Vicksburg.

Arthur H. Blanchard is the Executive Director of the National Highway Traffic Association, the National Pedestrians' Association, and the International Institute of Transport. He is also engaged in technical writing as the editor-in-chief of the International Highway Engineers' Handbook, the International Highway Traffic Control Handbook, and the International Transport Handbook.

W. Russell Tylor has been a member of the faculty of the University of Illinois for several years. Previously he taught at the University of Wisconsin while working there for his Ph.D. As an author, Professor Tylor has contributed to various technical periodicals.

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May 1933

Entered as second class matter September 23, 1930, at the Post Office at Easton, Pa., under the Act of August 24, 1912, and accepted for mailing at special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized on July 5, 1918.

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AMERICAN SOCIETY OF CIVIL ENGINEERS
Printed in the U. S. A.

CIVIL ENGINEERING

Published Monthly by the

AMERICAN SOCIETY OF CIVIL ENGINEERS
(Founded November 5, 1852)

PUBLICATION OFFICE: 20TH AND NORTHAMPTON STREETS, EASTON, PA.
EDITORIAL AND ADVERTISING DEPARTMENTS:
33 WEST 39TH STREET, NEW YORK

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Price, 50 cents a Copy; $5.00 a year in advance; $4.00 a year to Members and to Libraries; and $2.50 a year to Members of Student Chapters. Canadian postage 75 cents and foreign postage $1.50 additional.

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CIVIL ENGINEERING

MAY 1933

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NUMBER 5

Albany-Rensselaer Vertical-Lift Bridge

Design and Erection Features of the Heaviest Span of This Type

By SHORTRIDGE HARDESTY
MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
WADDELL AND HARDESTY, NEW YORK, N.Y.

AFTER fifty years of service, the vehicular bridge over the Hudson River at Albany, N.Y., became inadequate. It has now been replaced by a new structure with a 341-ft, vertical-lift span weighing 2,730 tons. In it silicon steel was largely used to keep down the weight. The span is operated electrically, with a gasoline engine in reserve. The operator's house is located at the middle of the lift span. Complete interlocking is provided, so that the span cannot be raised unless traffic is stopped. The lift span was erected in a nearly open position, by cantilevering out from the two towers. A second similar structure over the Hudson is now being constructed between Troy and Menands, N.Y.

IN 1883 the first vehicular bridge over the Hudson River between Albany and Rensselaer was completed from plans prepared by Boller and Hodge. It was designed as a double-deck railway and highway bridge, but the upper or railway deck was never finished. The bridge consisted of several pin-connected fixed truss spans and a swing span about 400 ft long, its superstructure being of wrought iron with the principal members of Phoenix sections or eye-bars. The original floor was of timber, but the construction was altered from time to time as traffic conditions changed. Cut stone masonry formed the substructure, which was founded on stone-filled cribs except for the swing span, under which a pile foundation was used. The structure is believed to have cost about $350,000. It was operated as a toll bridge for many years, the tolls varying from $70,000 to $92,000 per year. In 1918 it was taken over by the State of New York and made a free bridge.

This structure gradually became inadequate to handle the large volume of traffic involved. Congestion was aggravated by the fact that the approaches allowed traffic to leave or approach the bridge in many directions, so that interruptions and interferences developed. Also, the swing span was close to the water, requiring frequent openings and causing serious delays to traffic.

On January 24, 1930, Congress passed an act granting the State of New York permission to build a new bridge that would provide a clear channel 300 ft wide and a vertical clearance of 135 ft above high water when the movable span was opened. It was decided to build a bridge with a concrete deck that would accommodate four lines of traffic, and having a vertical clearance of

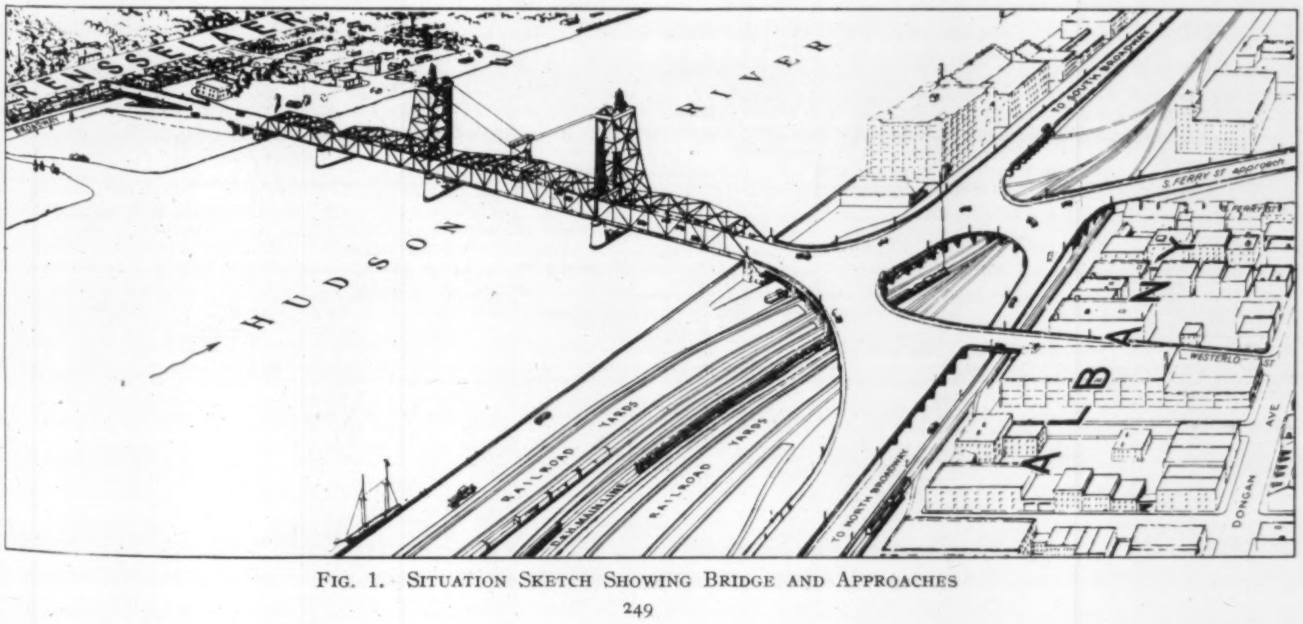


FIG. 1. SITUATION SKETCH SHOWING BRIDGE AND APPROACHES

35 ft above high water when closed. This clearance would permit ordinary river traffic to pass under the bridge with the movable span closed, and would also enable the west approach to pass over the Delaware and Hudson tracks. It was found that a vertical-lift span 341 ft long would best meet all the requirements.

There are five one-way ramps on the new Albany approach, as shown in Fig. 1. These ramps are so arranged as to reduce delays to a minimum; and traffic lights and signs are provided to control and direct traffic. A grade crossing problem was solved by moving the main line and freight tracks of the Delaware and Hudson Railroad to pass under the bridge approach, and by building a grade crossing structure at the intersection of the tracks and Madison Avenue. The Rensselaer approach problem was much simpler. There the approaches consist of one two-way ramp passing over Broadway and leading to Washington Street, and two one-way ramps extending north and south into Broadway.

Three fixed spans and a lift span compose the river structure, as shown in Fig. 2. Beginning at the Abany end, the span lengths are 222 ft, 341 ft, 222 ft, and 167 ft. The four spans are supported on three concrete piers carried to bedrock, and two abutments resting on piles. The 42-ft roadway is between the trusses, and the two 6-ft sidewalks are outside, on cantilever brackets.

Reinforced concrete was used for the roadway slabs and sidewalks, the roadway having a bituminous paving and the curbs being faced with granite. On the fixed spans, the roadway slabs are $8^1/_2$ in. thick and are reinforced with loose bars, but on the lift span, to keep down the weight, this thickness was reduced to $6^1/_2$ in. and welded truss reinforcement used. Various types of roadway were studied for the lift span, including several thin and light floors. Although the light floors showed a considerable reduction in the weight of the span and a moderate saving in its cost, the concrete slab with bituminous paving was preferred as being certain to give a service under heavy traffic not so definitely assured by the other types.

In the design of the bridge, H-20 loading was used. The live-load impact was determined from the formula $I = \frac{50}{l + 125}$, in which l equals the loaded length, while the stresses produced by the weight of the moving span and the counterweights were increased by 20 per cent to allow for impact and vibration. Wind loads were assumed to be 50 lb per sq ft when the span was seated and 20 lb per sq ft when it was raised. Both carbon and silicon steel were used. In Table I are given the basic tensile unit stresses assumed in designing the members of the floor system and trusses.

TABLE I. ALLOWABLE UNIT STRESSES IN TENSION, IN POUNDS PER SQUARE INCH

CONDITIONS OF LOADING	FLOOR SYSTEM		TRUSSES	
	Carbon Steel	Silicon Steel	Carbon Steel	Silicon Steel
Dead load + live load + impact . .	16,000	22,000	18,000	24,000
Dead load + 2(live load + impact) . .	....	....	24,000	32,000

The trusses are of the Warren type with verticals, and are riveted throughout. Carbon steel was used for the fixed-span trusses, and silicon steel for the lift-span trusses except the posts and the secondary members at the center of the span. Carbon steel was employed throughout for the stringers and cantilever brackets, and for the floor beams on the fixed spans. For the floor beams on the lift span, however, silicon steel was utilized. The end floor beams of each span are designed so that the span can be lifted by placing jacks under its end floor beams.

Carbon steel bottom laterals were used on the fixed spans; but for the lift span silicon steel was adopted because the elongation of the silicon-steel bottom chords and bottom flanges of the floor beams would stretch the bottom laterals to such an extent that carbon steel members would be overstressed. In all the spans the top laterals are of carbon steel. Silicon steel is not required for the lift-span top laterals, as the participation stresses, being due only to the shortening of the top chords, are only half as great as those in the bottom laterals. The sway frames and portals are of carbon steel. The sway frames are composed of single-plane

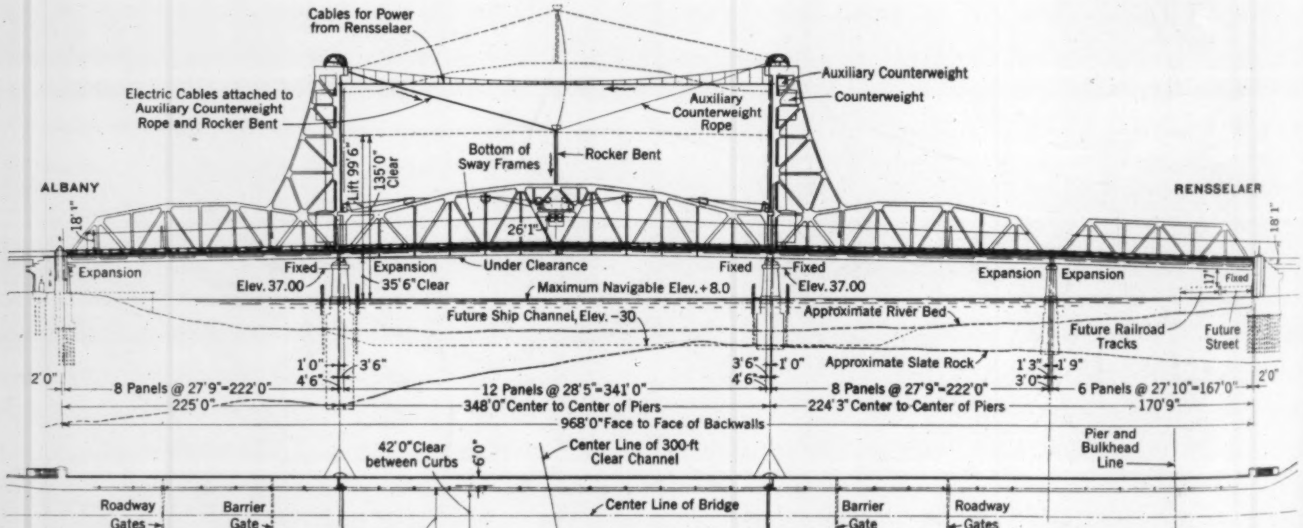

Cables for Power from Rensselaer
Electric Cables attached to Auxiliary Counterweight Rope and Rocker Bent
Auxiliary Counterweight
Counterweight
Auxiliary Counterweight Rope
Bottom of Sway Frames
Rocker Bent
Lift 99'6"
135'0" Clear
ALBANY
RENSSELAER
18'1"
26'1"
18'1"
Expansion
Fixed
Elev. 37.00
Expansion
35'6" Clear
Under Clearance
Maximum Navigable Elev. + 8.0
Fixed
Fixed
Elev. 37.00
Expansion
Expansion
17'
Fixed
Future Ship Channel, Elev. −30
Approximate River Bed
Future Railroad Tracks
Future Street
1'0"
3'6"
4'6"
3'6"
1'0"
4'6"
Approximate Slate Rock
1'3"
1'9"
3'0"
2'0"
8 Panels @ 27'9"=222'0"
12 Panels @ 28'5"=341'0"
8 Panels @ 27'9"=222'0"
6 Panels @ 27'10"=167'0"
2'0"
225'0"
348'0" Center to Center of Piers
224'3" Center to Center of Piers
170'9"
968'0" Face to Face of Backwalls
42'0" Clear between Curbs
6'0"
Center Line of 300-ft Clear Channel
Pier and Bulkhead Line
Roadway Gates
Barrier Gate
Center Line of Bridge
Barrier Gate
Roadway Gates
47'0" Center to Center of Trusses
6'0" Clear, Sidewalk
Hudson River

FIG. 2. ALBANY-RENSSELAER LIFT BRIDGE OVER THE HUDSON RIVER, NEW YORK
Plan and Elevation of Superstructure of River Spans

members, while the portals consist of double-plane members as deep as the end posts, in order to grip the top and bottom faces of these posts effectively.

As indicated in Fig. 2, the operator's house is located above the roadway clearance at the center of the lift span. In order to give the operator an unobstructed view of the bridge roadway, the bottom members of the sways and portals are made to clear inclined lines which at the center of the lift span are high enough to be above the operator's line of vision.

The wire ropes which carry the weight of the lift span—24 at each corner of the span, or 96 in all—are attached to double-web lifting girders of silicon steel which are riveted to the end truss members. At each end of each lifting girder, the web nearest the tower has 16 ropes attached to it, and the other web has 8.

The towers are of riveted construction, the front columns and the counterweight guide angles being of silicon steel and the other members of carbon steel. The front columns are closed sections consisting of 40-in. web plates, two 36-in. cover plates, and four 8 by 6-in. angles. The rear columns are composed of two channels and a cover plate, and the bracing consists of stiff members throughout.

In the top of each tower is a series of longitudinal girders 7 ft deep. The girders near each end of the tower carry the sheave bearings, and those nearest the center form temporary supports for hanging and lifting the counterweights during erection if required, or later if needed in emergencies. The lifting is effected by an arrangement of jacking girders and links.

Each counterweight is a single block of concrete weighing about 1,370 tons, cast in a stiffened steel box. In the upper part, wells are provided in which concrete blocks can be placed to secure exact balance.

The machinery house is located at the center of the lift span, just below the top chord (Fig. 3). It is about 33 ft long by 24 ft wide and contains the operating machinery except the drum units; the motors, the gas engines, and the motor-generator set; and the main switchboard. Located immediately below the machinery house is the operator's house, about 10 ft long by 24 ft wide, containing the control desk, the gate controls, and the electric meters. The houses have reinforced concrete floors and roofs of lead clad copper on timber sheathing, while the walls are covered with flat asbestos board. Above the machinery house, four transformers and a switch house containing high-voltage apparatus are mounted on a platform.

Platforms, stairways, and ladders are provided to give access to all parts of the lift span and towers. In general they are of open grating.

The lift span is by far the heaviest yet constructed, but that of the Troy-Menands Bridge, also over the Hudson River, which will be completed shortly, will be of the same length and weight. The weight of the span is 2,730 tons, made up as shown in Table II.

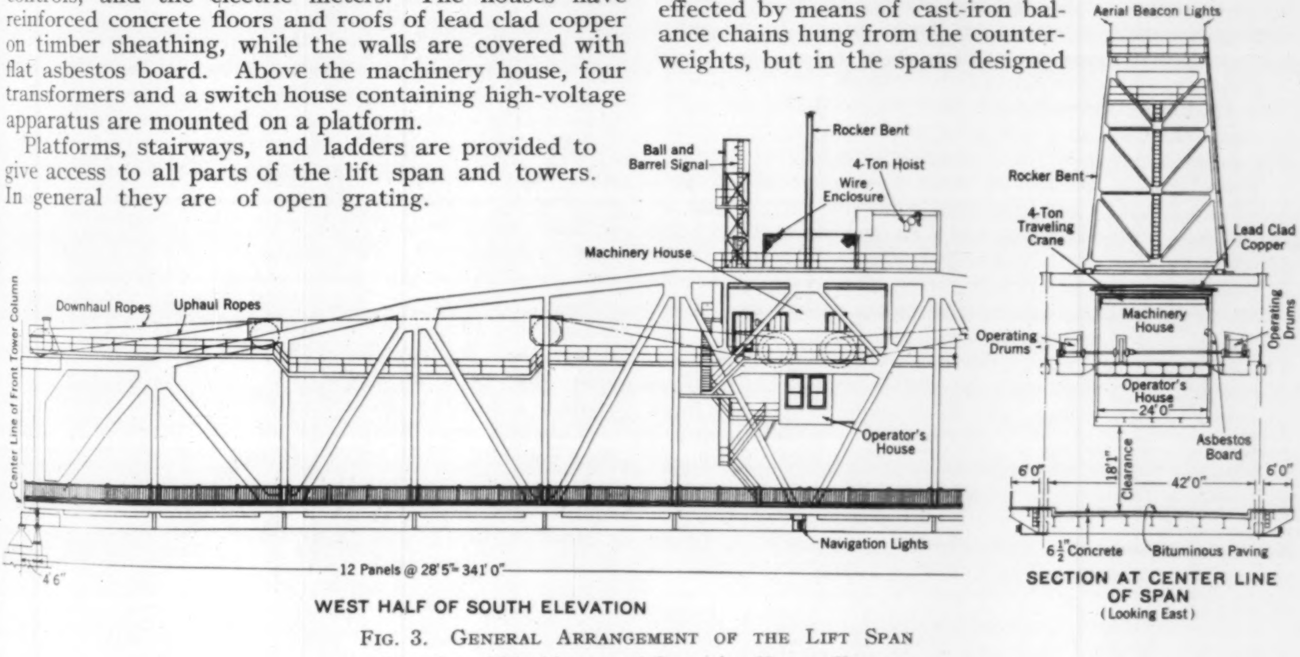
TABLE II. WEIGHT OF VARIOUS PARTS OF THE LIFT SPAN

Deck	2,220,000 lb
Structural steel	2,620,000 lb
Sidewalk railings	50,000 lb
Grating and pipe railings	50,000 lb
Machinery and operating ropes	310,000 lb
Electrical equipment	60,000 lb
Gas engine	5,000 lb
Houses	145,000 lb
Total	5,460,000 lb

There are 96 improved plow steel main counterweight ropes $2^3/_8$ in. in diameter, of 6 by 19 construction with a hemp center. Each rope carries a load of 58,000 lb. Since its specified ultimate strength is 447,000 lb, a safety factor of over 7.7 is provided. The ropes, which have drop-forged open sockets at each end, are dead-hitched at the counterweight end, but are connected to the span lifting girders with adjusting screws 4 in. in diameter. These screws permit the ropes to be adjusted initially to equal tension and readjusted later if found necessary. At each corner of the span, the 24 ropes are arranged in 3 groups of 8 ropes each.

The 12 counterweight sheaves are 8-rope sheaves of 15-ft pitch diameter, the journals being 15 in. in diameter and 22 in. long. The sheaves and bearings are of cast steel, the shafts of forged nickel steel, and the bushings of Grade B phosphor bronze. Since the sheaves were required to have shrink fits on their shafts, each sheave was bored about 0.01 in. smaller than the outside diameter of its shaft, then heated in a vat of boiling water, and the cold shaft set into the heated sheave. Each sheave is further secured to its shaft by six tight-fitting dowels $2^1/_2$ in. in diameter.

Since about 100 ft of the main ropes, weighing about 90,000 lb, shifts from the span side to the counterweight side as the span is raised, the operating equipment would have to handle unbalanced loads of this amount if no balancing devices were provided. In some of the earlier lift spans, such balancing was effected by means of cast-iron balance chains hung from the counterweights, but in the spans designed



WEST HALF OF SOUTH ELEVATION

SECTION AT CENTER LINE OF SPAN (Looking East)

FIG. 3. GENERAL ARRANGEMENT OF THE LIFT SPAN
Location of Machinery and Operating Houses Shown

by Waddell and Hardesty in recent years this result has been secured by means of auxiliary counterweights.

Several different arrangements of such counterweights have been used. In the Albany bridge, the auxiliary counterweight ropes are attached to the top of a rocker bent supported overhead at the center of the lift span, and of such height that its top is 50 ft below the top of the towers when the span is down, and 50 ft above when the span is up. The ropes have a dead hitch at the top of the west tower, while at the top of the east tower they pass over sheaves and thence downward to the auxiliary counterweight, as may be seen in Fig. 2. This counterweight is of such weight that the vertical component of the stress in its ropes equals the excess weight of the main ropes when the span is seated. The entire system then remains in balance throughout the movement of the span.

In addition to balancing the main ropes, the rocker-bent scheme permits the electric cables to be brought to the motors at the center of the lift span without the use of sliding trolleys or long swinging loops. The cables are carried to the top of the west tower, thence along the auxiliary counterweight ropes, and down the rocker bent. They are sufficiently flexible to accommodate themselves to the small movements at the top and bottom of the rocker bent and at the top of the west tower. Certain features of the various auxiliary counterweight arrangements are covered by patents.

The lift span is guided by rollers, which run on the four tower columns. The counterweights are guided by sliding shoes, which engage guide angles. Air buffers are provided at the four corners of the span, beneath the end floor beams.

OPERATING EQUIPMENT

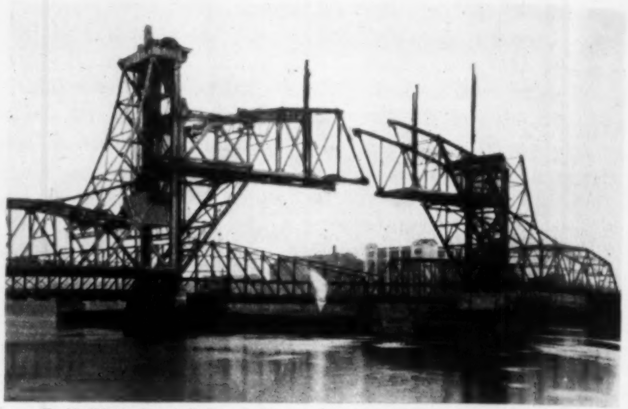
Normally the span is operated by two 250-hp motors, which will raise it to the full height or lower it in two minutes. The motors drive the operating drums through a single-step herringbone gear reduction at the center of the span and two-step, spur gear reduction units at the drums. Three electric solenoid brakes are provided.

In the event of a failure of the electrical equipment or power, the span can be operated by means of a 240-hp, 8-cylinder gasoline engine, which drives through a spur-gear reversing unit. A hand brake is provided for use with the gasoline-engine drive, and a claw clutch to disengage the drive from the rest of the machinery. The engine is intended to be run normally at 1,200 rpm, at which speed it will raise the span in eight minutes but it can be operated at a considerably higher speed

There are 16 improved plow-steel operating ropes, two uphaul and two downhaul ropes at each corner of the span. These ropes are $1^1/_2$ in. in diameter, of 6 by 19 construction, with a hemp center. The ropes pass from the operating drums over secondary deflector sheaves, and then around the main deflector sheaves at the ends of the span to the tops and bottoms of the towers, where they are fastened with adjusting screws. Reference to Fig. 3 will show the arrangement. The drums and sheaves are 6 ft in diameter. As each rope has a specified ultimate strength of 185,000 lb and a maximum computed stress of but 34,400 lb, its factor of safety is nearly 5.5. To prevent the operating ropes from swinging in the wind and slapping against the tower columns, two vertical 12-in. channels, between which the ropes hang, are riveted to the front face of each column.

A double set of gates is provided to control traffic. About 140 ft from each end of the lift span is a pair of wooden gates of the usual grade-crossing type; and nearer each end of the lift span is a heavy steel barrier gate, which is lowered from overhead. In operation, one-half of each wooden gate is lowered first, to stop oncoming traffic. After the traffic between the gates has been cleared, the other halves of the wooden gates are lowered and the barrier gates are closed. All gates are driven by electric motors.

Span locks are provided at the four corners of the lift span, at the top chord level. They consist of heavy bars supported on the towers and engaging rollers on the lift span. The locks are operated at the same time as the barrier gates, and by the same mechanism.



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ERECTION METHOD AND SEQUENCE, OCTOBER 21, 1932
Outdated Swing Bridge in Background

Special ball-and-barrel signals, as required by the U.S. Government, are mounted on top of the lift span. They are operated by electric motors. In an emergency the gates, locks, and ball-and-barrel signals can be operated by hand.

ELECTRICAL EQUIPMENT

Alternating current at 4,000 v (3 phase, 60 cycles) is provided for operating the lift span. There are two sources of supply, one on each side of the river. A selector switch in the switch house on the platform above the machinery house normally connects with the Albany source of power but automatically throws in the Rensselaer supply in the event of failure of the former. From the switch house the power is carried down to the motor-generator set in the machinery house.

The motor-generator set for supplying power to the span motors consists of a 500-hp, 4,000-v, squirrel-cage, a-c motor driving a 350-kw, 500/250-v, d-c, differentially compound-wound, separately-excited and self-excited generator, with characteristics such that the voltage of its output drops as the current demand increases. The exciter is a 20-kw, 250/250 v, compound-wound, d-c generator of constant-voltage characteristics, designed to supply excitation for the generator and the span motors, and power for the electric brakes and various contactors in connection with the span motors.

The two span motors are of the 250-hp, 230-v, d-c, shunt-wound, mill type. If operated on a constant-voltage source of power, they would be practically constant-speed motors; but on account of the drooping characteristics of the generator, the motor speed drops as the load increases, thus giving speed-torque curves similar to those of series motors.

Normally both motors are in service, but either motor alone can handle the span. The maximum starting torque of each motor is normally 6,000 ft-lb, but when operating with one motor, its field is forced and its maximum torque raised to 8,500 ft-lb. In the event of two-motor operation, the motors are in series, so that the voltage on each motor is about 250 v; while for single-motor operation the voltage of the generator output is reduced by means of resistance placed in its self-excited field. Speed control, for either two-motor or single-motor operation, is effected by changing the resistance in the separately-excited generator field, thus varying the voltage of the generator output. This type of control is known as the variable-voltage, or Ward-Leonard system. In addition to providing a smooth, flexible control, it avoids overloading the power supply, because of the drooping characteristics of the generator.

Current for the small motors, the electric heaters, and the service lights is supplied from 4,000-v to 230/115-v transformers. An engine-generator set is provided to furnish current for these services if the power should fail.

The main switchboard and control panel board are located in the machinery house, together with the resistors required in connection with the control.

The main control desk is located in the operator's house. It contains the span and barrier gate controllers; switches for lights and other circuits; certain indicator lights; and sealed switches for by-passing, in an emergency, certain sequence interlocks in the controls. The west traffic-gate control desk is mounted in the operator's house, at a west window, and the east traffic-gate control desk in the same house is at an east window. The meter panel, also placed in the operator's house, contains two a-c voltmeters, two d-c voltmeters, and one d-c ammeter. In the machinery house and in the operator's house there are two indicators—pointers moving vertically along graduated scales—showing the operator the height of the span at any instant.

SAFETY EQUIPMENT PROVIDED

A limit switch, driven from the operating machinery, is provided to cut off the power from the span motors and set the three brakes, one at a time, near each end of the span's travel. This switch also cuts off the ignition circuit of the gasoline engine and controls the navigation lights and certain indicating lights and interlocking circuits. The span control is so arranged that, after the span has passed through the limits near each end of its travel, power will be made available for further operation of the span by returning the controller handle to neutral. The various small motors are also equipped with limit switches.

In addition to warning lights on the gates, there are four red and green highway traffic signals, and two stop-sign and warning-bell units. Traffic-directing signs have also been installed at the ends of the river structure and on each approach.

The controls and switches for operating the span, gates, and traffic signals are so interlocked that they can be operated only in the proper sequence. Under normal operation, the signals are set first; next the four wooden gates are closed; then the barrier gates are closed and the span locks disengaged; and finally the span is raised. In the reverse operation the span is lowered; the barrier gates are opened and the span locks engaged; the wooden gates are opened; and last, the traffic signals are cleared. In general, none of the foregoing operations can be performed unless the next preceding one has been completed.

In the fabrication of the structural metal, the specifications required that all rivet holes be sub-punched and reamed. Truss chords and tower columns were assembled with their splice plates before reaming, while rivet holes in web members and gussets were reamed to accurately-set metal templates. Special precautions were required at the bottoms of the tower columns, since both the columns and the truss gussets were to bear on the shoes. The columns and the truss members were assembled and the joint reamed, and the bearing surface planed while the members were thus assembled.

SEQUENCE OF ERECTION

The 167-ft span and the two 222-ft tower spans were erected in a conventional manner on timber falsework towers placed under every second panel point and founded on timber pile bents. A stiff-leg derrick, resting on the floor steel and advancing two panels at each move, was used as a traveler. At first it was planned to erect the lift span, complete with machinery and deck, on falsework away from the site and float it into place while navigation was suspended during the winter of 1932–1933. It was finally decided, however, that it would be less hazardous, less dependent on river conditions, and less obstructive to navigation to erect the lift span in place at a height of 119 ft above high water. During erection, the span was supported on triangular steel falsework in the planes of the trusses, the corners of the triangles being at the L_0 and L_2 points of the lift span and the base of the tower. The triangles were tied back to the top chords of the tower spans by means of eye-bars, as shown in one of the photographs. All the steel was lifted from barges in the river.

The span traveler erected the bottom section of the tower and the triangular falsework for the lift span, then set the first two panels of the lift-span floor and a guy derrick resting on this floor. The guy derrick erected the first two panels of the lift-span truss around itself and then jumped to the top chord of the lift span, from which position it completed the erection of the tower. A second guy derrick was then erected on the floor at L_2, and proceeded to erect the remainder of the half lift span as a cantilever. Closure at the center was accomplished by adjusting the half spans with jacks on roller shoes placed under the L_2 points, and by wire-rope tie-downs at the L_0 points.

Especial care was given to the finishing of the sheave journals and bearings and the lining up of the bearings. As a result, the span operates very smoothly, the indicated running journal friction being less than 5 per cent.

The general contract for the whole structure was awarded on November 10, 1931; the river piers were completed in July 1932; erection of the bridge was started on June 7, 1932; and the bridge was opened to traffic on January 23, 1933. At that time certain of the approaches had not been finished because they would have interfered with traffic over the old bridge. Immediately after the bridge was put in service, the removal of the old bridge and the completion of the unfinished approaches were begun. It is estimated that the entire job will be completed about August 1, 1933.

The contractors for the entire work were Booth and Flinn. The fabrication and erection of the superstructure for the river spans were done by the McClintic-Marshall Corporation, as subcontractors.

The bridge is being constructed by the Department of Public Works of the State of New York, under the direction of Frederick Stuart Greene, M. Am. Soc. C.E., Superintendent, T. F. Farrell, Chief Engineer, and H. O. Schermerhorn, Assoc. M. Am. Soc. C.E., Assistant Chief Engineer, with Oscar Hasbrouck in charge of the construction. Waddell and Hardesty were retained as consulting engineers to design the superstructure of the river spans.

Westward the Course of Empire—

Extending a Network of Transportation Over the Country in a Single Century

By **Edward P. Lupfer**

MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
CONSULTING AND CONTRACTING ENGINEER, BUFFALO, N.Y.

FOR engineers, the romance of transportation in America has a special fascination. In rapid succession, trails, highways, and canals were developed, and then came the railroad. Little did the nation realize that this newest mechanical contrivance was the key to successful expansion and development. Mr. Lupfer recalls many of the scenes in this amazing transportation drama, some of which took place before his eyes. The voyageur, the trapper, the pioneer, the "forty-niner," the pony mail rider, the stagecoach driver, and finally the railroad engineer, all played their successive parts. This paper is a somewhat condensed version of the address delivered by Mr. Lupfer before the past and present officers of the Society at their annual dinner on January 17, 1933.

PONY EXPRESS
DOLLAR
WELLS FARGO & CO.

IT is no longer a rare accomplishment to adjust the radio with a few simple turns of the dials and receive messages from all parts of the world, one after the other, almost at the same instant they are uttered. This is symptomatic of what modern research has done in the science of communication. Or we can climb into an airplane on the Atlantic seaboard and, following commercial schedules, reach the Pacific Coast 23 hours later. It is promised that even this remarkable time will be reduced materially, perhaps to a total of 16 hours. This shows what recent advances have done to step up progress in modern transportation.

With these everyday experiences in mind, it is difficult to visualize the tremendous handicaps that faced the nation a century or more ago. The history of this progress reads like a romance. Engineers, who took such a lively part in all the advances, should find much of interest and pride in recalling some of the outstanding events.

LAND FOR ALL FUTURE GENERATIONS

When, in 1801, Thomas Jefferson was inaugurated the third President of the United States, he asserted that there was in this country "land enough for our descendants to the hundredth and thousandth generation." Neither he nor his colleagues clearly envisaged the further territory that would be needed for the building of this nation, or realized that new modes of transportation would be required for its utilization.

Even then events were shaping our destiny. Napoleon, who had secured the Louisiana Territory from Spain in 1800, was laying plans for the establishment of an empire on American soil, west of the Mississippi River. But by 1803 he was badly in need of funds for his campaigns, and he sacrificed his American possessions to his European ambitions. This purchase by the United States, the greatest peaceful annexation of territory the world ever saw, doubled the area of the nation and later added 14 great states to the American Union.

As time passed, slowly and laboriously turnpikes and canals came into existence east of the Allegheny Mountains, but the saddle horse and the stagecoach furnished the prevailing mode of "rapid" transportation. In 1825 there was not a single steamship on the seas of the world, nor a single train of cars drawn by a locomotive. The State of Ohio was known as the "backwoods" or the "frontier," and there were traditions abroad of boundless fertile prairies beyond the Ohio, stretching out to the Mississippi River. Conestoga wagons, drawn by six-horse teams, handled the trade between New York, Philadelphia, Baltimore, and Pittsburgh. With the completion of the Erie Canal in that same year, Buffalo became a western terminus, and caravans of oxen and mule teams started from that point for their trek into the western country.

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Those living on the Atlantic seaboard knew Pittsburgh, St. Paul, New Orleans, and St. Louis, originally settled by the French, as distant settlements. St. Louis, situated strategically on the Mississippi, in close proximity to the mouth of the Missouri, and easily reached from the east by the Ohio, was even then the distributing point, by oxen and mule team and by river connections, for the far western prairie reaches, and for the fur trading voyageurs of the upper Mississippi and the Missouri rivers.

With the advent of steam came a revolution in the transportation system of the United States and of the world. This revolution began about 1830, little more than a hundred years ago. Hardly had steam come into use when visions of an extension of empire became rampant in legislative halls in Washington, in newspapers throughout the Union. In books and periodicals the question was discussed as to when it would be possible to connect the eastern coast with the Pacific. There was debate and discussion, and no less a national idol than Daniel Webster, who served in the United States Senate from 1827 to 1850, denounced the very thought of connecting the two oceans by rail.

There was, however, United States Senator Thomas Benton, of Missouri, who served his state and nation well from 1821 to 1851, or for a period of thirty years. He was in close touch with traders, trappers, miners, and explorers in the territory west of the Mississippi. On the floor of the Senate he early took up the fight for a transcontinental steam road, claiming that the northern route, through the mountain passes of Montana, was the proper one. In his opinion the best engineers in existence were the buffalo; great herds of these drifted northward and westward in the fall of the year, seeking the lower mountain passes of Montana into the Flathead and Kootenai country, where they could secure the benefit of the milder winters, tempered by the Chinook winds which blow eastward from the Puget Sound country in early spring. Later, however, when Benton found he could not force the adoption of the northern route, he used his remarkable influence to secure approval of the central route. In seeming justification of his theory of the low mountain passes in the north, in later years three of the six great continental railroads adopted routes crossing the Rockies in Montana (Fig. 1).

Prior to 1835 there was little or no travel overland, from the Mississippi River to the Pacific Coast, but from that time on, this vast, at first practically unknown empire, offered a veritable paradise, rich beyond dream, for big game hunting, for exploration, and for settlement—an opportunity such as the world has rarely seen.

The purchase or acquisition of all the territory west of the Mississippi by 1853 had opened up the incredible speculative possibility of hundreds of millions of acres of land. This alone would have provided the impetus for the settlement of the West; but added to it was the alertness and restlessness of the American people. The discovery of gold in California in 1849 was simply another contributing factor in quickening the development of transportation across the Western area.

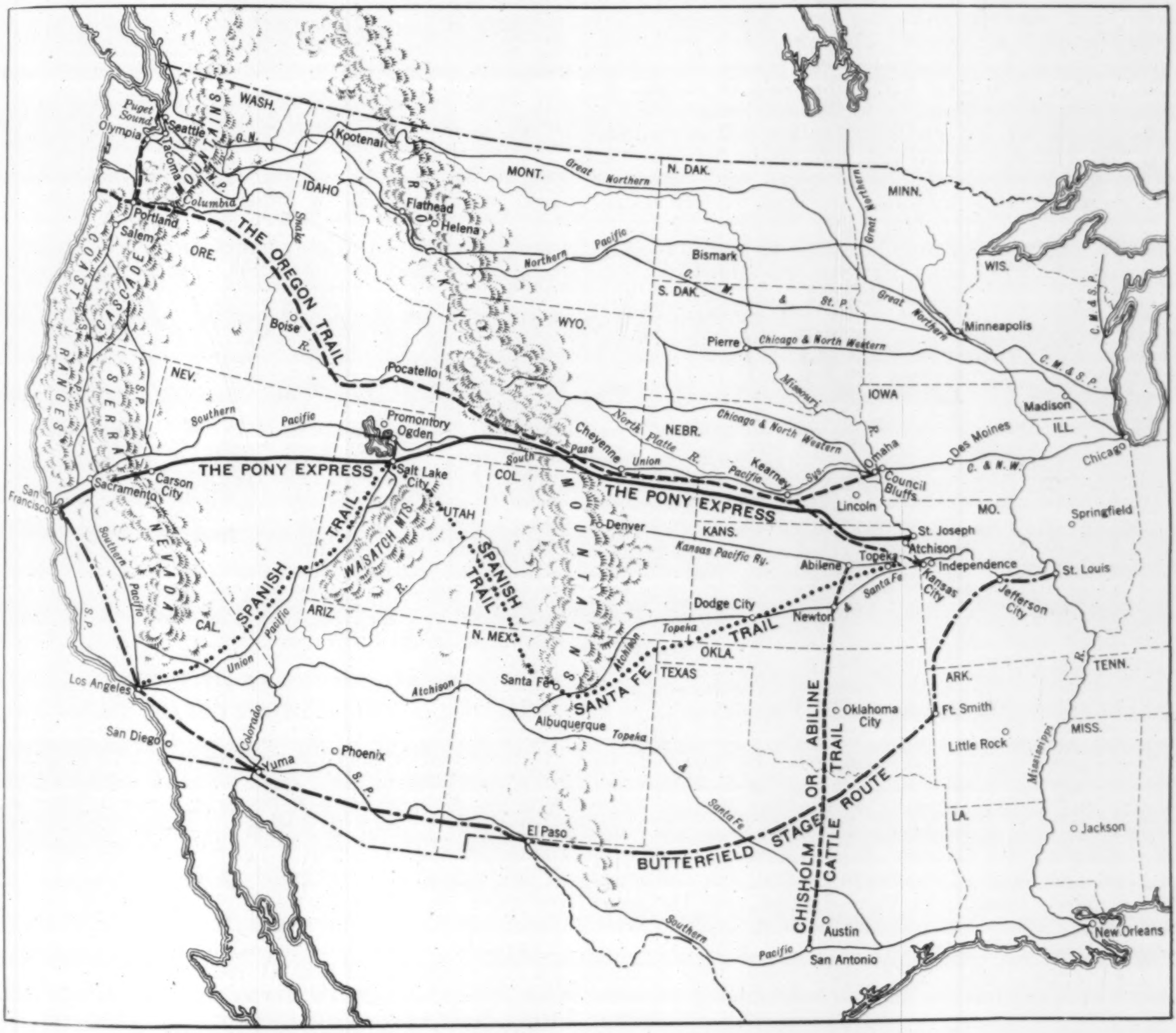
During the 1830's and 1840's, nearly all communication with California and Oregon was by sea to the Isthmus of Panama or Nicaragua, then by portage across to the Pacific, and by sailing vessel or steamer up the west coast. The time required to make the trip by this route was many weeks, while for the route by way of Cape Horn, used for most of the heavy shipping from the Eastern states, from 8 to 10 months were needed.

As the country west of the Mississippi River was opened up, we witnessed the swift panorama of transportation by pack trains, ox-carts and pushcarts, horse and mule caravans, stagecoaches, camel trains, and the Pony Express. Finally, with the introduction of the railroad, politics began to play a part, and to enter largely into every move of this great human force in building up the western frontier.

The South insisted on keeping open the southern routes to the West, and the North was equally anxious to maintain political prestige by keeping open the northern routes.

EMPHASIS ON THE SOUTHERN ROUTE

Beginning with 1850, mail service was supplied by pack train and stagecoach from Independence, Mo., by way of the central route, along the North Platte River and the South Pass of the Rockies in Wyoming to Salt Lake City. The earliest complete overland mail service was established in 1851, when a contract was



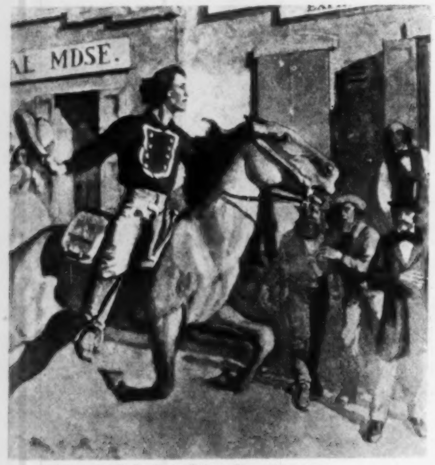
WASH.
Puget Sound
Olympia
Seattle
Tacoma
G. N.
Kootenai
MOUNTAINS
N. P.
Columbia
Portland
Salem
IDAHO
MONT.
Great Northern
N. DAK.
MINN.
Great Northern
Flathead
Helena
Northern Pacific
Bismark
C. M. & St. P.
S. DAK.
Great Northern
Minneapolis
WIS.
C. M. & S. P.
COAST RANGES
CASCADE
ORE.
THE OREGON TRAIL
Snake
Boise
R.
ROCKY
WYO.
Pierre
Chicago & North Western
Missouri
NEV.
SIERRA
NEVADA
S. P.
Pocatello
Southern Pacific
Promontory
Ogden
South Pass
Cheyenne
Union Pacific
North Platte R.
NEBR.
Kearney
Chicago & North Western
IOWA
R.
Omaha
Council Bluffs
Des Moines
C. & N. W.
Madison
ILL.
Chicago
THE PONY EXPRESS
San Francisco
Sacramento
Carson City
Salt Lake City
UTAH
COL.
MOUNTAINS
THE PONY EXPRESS
Lincoln
St. Joseph
Atchison
MO.
Springfield
Denver
KANS.
Kansas Pacific Ry.
Abilene
Topeka
Independence
Kansas City
St. Louis
Jefferson City
TRAIL
SPANISH
WASATCH MTS.
SPANISH TRAIL
Southern Pacific
CAL.
ARIZ.
Union Pacific
R.
Dodge City
Newton
Atchison Topeka & Santa Fe
TRAIL
SANTA FE
N. MEX.
OKLA.
TEXAS
TENN.
Los Angeles
Santa Fe
Atchison
Albuquerque
Topeka
Oklahoma City
ARK.
Ft. Smith
Little Rock
MISS.
Mississippi R.
San Diego
Colorado
Yuma
Phoenix
S. P.
& Santa Fe
CHISHOLM OR ABILINE TRAIL
CATTLE ROUTE
BUTTERFIELD STAGE ROUTE
El Paso
LA.
Jackson
Austin
Southern Pacific
San Antonio
New Orleans

Fig. 1. Wagon Routes of 1850 and the Present Transcontinental Railroads

entered into between Charpenning and the Federal Government to carry the mail monthly by pack train from Salt Lake City to San Francisco, the time consumed to be not more than 30 days each way. The time actually consumed was anywhere from 23 to 47 days, depending on the weather. This service continued until 1858.

When President Pierce took office in 1853, he appointed Jefferson Davis as Secretary of War. Mr. Davis had seen service in the Mexican War and was convinced that the solution of the problem of quick transportation to the Pacific Coast was by the southern route and by means of camel trains. In 1854, he introduced in Congress a bill providing for such a route; it was defeated. Again, in 1855, he introduced his bill and it was passed, carrying an appropriation of $30,000 for the purchase of camels. A vessel was fitted up and sent to Arabia, where 75 of the finest blooded Arabian camels were purchased. They were brought to the Texas coast, with their Bedouin drivers, and at once put into Army service in Texas, New Mexico, and Arizona. Their feet soon grew sore, however, from the flinty soil, so different from the sands of Arabia. Then they were shod with leather boots, but this arrangement proved futile, and after a year or so they were either sold to circuses or turned out on the desert to forage for themselves.

Sentiment for the southern location still prevailing, the first complete stage and mail route between the Mississippi River and the Pacific Ocean was established by Congress in 1858, by way of the Southwestern states. A contract was given to Butterfield, by which he was to operate stage coaches from St. Louis to San Francisco, a distance of 2,700 miles, by what was called the "oxbow route." This passed through Fort Smith, Ark.; El Paso, Tex.; the southern part of Mexico and Arizona; and thence through the State of California, from its southern border to San Francisco. A schedule time of 23 days was established, and the line was operated at a loss for a period of two years.



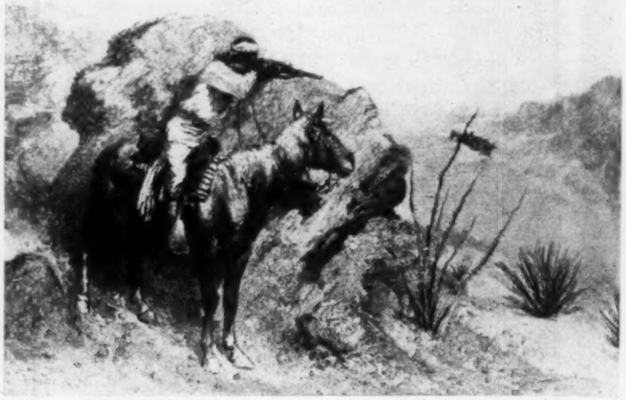
Courtesy U.S. Post Office Department

WELLS FARGO PONY EXPRESS RIDER, 1860

Three decades, between 1840 and 1870, compassed the pioneer winning of the Far West. They were filled with more drama and more romance than any others of the century. It was during these years that the Oregon Trail, the Santa Fe Trail, the California Trail, the stagecoach, the Pony Express, and the completion of the railroad connections from East to West played their important parts.

The Oregon Trail, 2,000 miles long, was without doubt the most traveled and the most famous highway in the United States. Caravans starting at Omaha, St. Joseph, or Independence, on the Missouri River, converged at Fort Kearney, Nebr., followed along the North Platte River, traversed Nebraska, and crossed the Rockies in Wyoming by the South Pass. Then this trail wound its way into the valley of the Snake River, and thence to the Columbia River, Puget Sound, and the Pacific Coast. Over it passed a vast migration of settlers to hold Oregon for the United States. It is estimated that some 200,000 Americans treked into Oregon over this trail during these three decades.

It was over this route that the Mormon migration came, from 1847 on, turning southward at the South Pass to Salt Lake City. In my earlier days I spent three years in Utah, in railroad building. Many an evening have I sat before open fires in various Mormon homes and listened to gray-haired "mothers of Israel" recite their experiences of the long journey from Council Bluffs to Salt Lake City, by covered wagon, the women of the caravans frequently pushing hand carts.



A HAZARD OF PRAIRIE SCHOONER TRANSPORTATION

By Frederic Remington, from *Harpers Magazine*, Vol. 82, Page 861

And it was this trail, as far as the South Pass in Wyoming, that was used by Russell, Major, and Waddell in their great freighting projects, in which thousands of oxen, mules, and horses were used to haul supplies from Independence or St. Joseph, Mo., or from Omaha, Nebr. The freight that passed over this trail went to all parts of the Far West and Northwest. The trail from the South Pass of the Rockies to the Southwest, to Salt Lake City and thence to the Coast, was known as the California Trail.

PONY EXPRESS AN AMBITIOUS VENTURE

Then too, in 1860 and 1861, this Old Oregon Trail, combined with the California Trail, was fundamentally the route used by the most spectacular of all early means of transportation, the Pony Express mail service. With the discovery of gold in the Sacramento Valley in 1849 came a great migration to California, but the routes followed by the "forty-niners" and the gold seekers of the early fifties were mostly farther to the south, or by water to the Isthmus of Panama or Nicaragua. The South was bending every effort to hold the routes in the southern zone, but the clamor by the Californians for swifter and better mail service became irresistible, so that in the spring of 1860, a pony express service for mail twice a week was put into effect from St. Joseph, Mo., to Sacramento, Calif., and thence by boat to San Francisco.

The telegraph had by this time reached points on the Missouri River. Russell and Major conceived the idea of a ten-day mail service from the Missouri River to the Coast. They purchased 500 saddle horses, established 190 stop stations, and employed 80 riders, at an outlay of $100,000. The distance was 2,000 miles. The weight of the young riders was limited to 125 lb, and they were to ride at top speed in relays from 75 to 100 miles, changing horses every ten miles.

On April 3, 1860, this service was put into effect, with a 13-day schedule for mail from coast to coast: three days from New York to the Missouri River by train and ten days by Pony Express. The original postage charge by Pony Express was $5 per one-half ounce but was later very materially reduced. On the prairie sections of the line the best blooded stock was used, but through the mountains and desert country the bronco or mustang bore the brunt of the riding. The Western bronco breed is not to be dismissed lightly. It comes to us from Spain, by way of Mexico, and has a strain of Arabian fleetness in its makeup.

Courtesy Southern Pacific

The Iron Horse Superseding the Covered Wagon

Governor Stanford's Special Train en Route to the "Last Spike" Ceremony at Promontory, Utah, May 10, 1869

For 19 months this Pony Express service was kept up night and day. When Lincoln's first inaugural address was delivered, in 1861, the riders made the incredible time of 7 days and 17 hours from the Missouri to the Pacific, or at the rate of 10.8 miles per hour. The length of time the riders could stand this terrific pace was limited, and the turnover of riders was heavy. The distance covered during the life of the service was 650,000 miles.

This undertaking, as well as most of the stage routes, was conducted at great financial loss. In the meantime, the Pacific Telegraph Company had built its line from Omaha, Nebr., across the plains, reaching Salt Lake City in June 1862. The Pony Express was abandoned in October 1861.

Although the Federal Government constantly kept troops along the various routes of travel, they were wholly unable during the fifties and sixties, and even later, to cope with the Indian raids, which were constant. As late as 1865, stage route stations were wiped out completely from Denver to Atchison, Kans., by raiding Indian tribes. Before leaving the Old Oregon and California trails, the fame of which will grow with the years, it should be noted that the Union and Central Pacific railroads closely follow these routes.

Space forbids detailed comment on the Santa Fe Trail, second in importance among the overland highways in the upbuilding of this nation, which had its eastern terminus at Independence, Mo., and its western at Santa Fe, N.Mex. Its influence on the settlement of the Southwest was tremendous, since from Santa Fe close relations by trail and wagon road were kept up with Texas, old Mexico, and California.

Meanwhile railroad building had been progressing. From 1830 onward it advanced slowly in many parts of the East, although it ceased rather abruptly in 1857, at the beginning of the depression that preceded the Civil War.

In 1848, Congressman Pollock, of Pennsylvania, was the first man to obtain formal action in Congress in favor of the construction of a Pacific railway. His resolution called for the appointment of a committee to inquire into the necessity for such construction. In an address he said, "At the risk of being considered insane, I will venture to predict that in less than 25 years a railroad will be constructed and in operation between New York and San Francisco." Highly as he was respected, his prediction was received with general incredulity; but on the tenth of May 1869, just 21 years after his remarkable prophecy, the last spike was driven in a continuous railway line from coast to coast.

In 1853, congressional action had been taken for reconnaissance surveys for a railroad from the Mississippi and Missouri rivers to the Pacific Coast. Secretary Jefferson Davis had five such surveys made, and gave a full report of them to Congress in 1855. Beginning in the north, these surveys covered ground near the 48th, 42d, 39th, 35th, and 32d parallels. Out of these surveys and Secretary Davis's report in 1855, gradually grew three recognized routes to the Coast, all of which became famous in later years—the northern, the southern, and the central route.

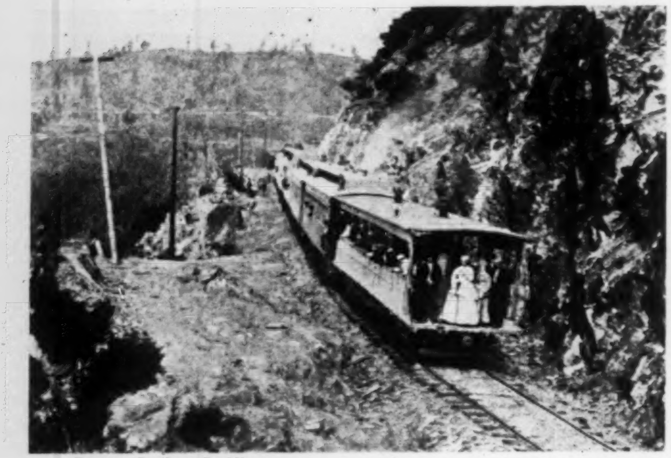
Courtesy Southern Pacific

Driving the Last Spike at Promontory Point, Utah

The Two Men Shaking Hands Are the Chief Engineers of the Two Railroads, S. S. Montague, of the Central Pacific, and G. M. Dodge, of the Union Pacific (later Hon. M Am. Soc. C.E.)

By 1860, in all a half million people had pioneered into the West, beyond St. Paul, Omaha, St. Joseph, Independence, and New Orleans, which guarded the great Western frontier. These cities lie in almost a straight line from north to south. In that year there was less than 50 miles of railroad west of the Missouri River and less than 250 miles of telegraph lines.

In 1862, President Lincoln signed a bill creating the Union Pacific and the Central Pacific railroads. In January 1863, the Central Pacific railroad started its construction from Sacramento toward the east. In December 1863, in north Omaha, ground was broken with fitting ceremonies for the construction of the Union Pacific to the west; but although both lines were started in 1863, practically no progress was made at either end until near the close of the Civil War. Four years of warfare had greatly unsettled business interests. Strong sectional feeling between Northern and Southern interests was rife. The undertaking was enormous; the entire route was practically devoid of construction materials. On the eastern end, ties were brought from Michigan and Pennsylvania; iron rails and their fittings were transported from the mills of the East; and bridge and structural supplies were wagoned by bull team from central Iowa. The costs were staggering; shipping was uncertain; gold was at a 50 per cent premium; labor was scarce; and the entire route from the Missouri to the Pacific was dangerous because of hostile Indians.



Courtesy Southern Pacific

DE LUXE ATLANTIC AND PACIFIC EXPRESS ABOUT 1870
Open Observation Car—Train Stopped at Cape Horn in the American River Canyon

At the western end, in California, conditions were even more perplexing. All iron, rolling stock, and railway materials were manufactured in the Atlantic states and had to be transported by sea around Cape Horn to San Francisco—a long voyage. Shovels, picks, and black powder were the only aids to grading. Although dynamite was invented in 1866, none was used in the construction of the Central Pacific. In the Sierra Nevadas, where snow fell to a depth of 20 ft, 15 tunnels were driven and 40 miles of snowshed were built. Oxen were used to a great extent for transportation, and Chinese were used for labor. For about $3^1/_2$ years construction continued, and the two lines met at Promontory, Utah, on May 10, 1869, when Governor Stanford of California, with a silver hammer, tapped the last spike into a highly polished laurel tie. The great struggle was ended. The impossible had been accomplished. The oceans had been connected by rail.

In the settlement of the great prairie section of central and southern Kansas, the Santa Fe Railroad, chartered by the Kansas legislature in 1860, played a major part. Construction began at Kansas City in 1868. By 1872, it had reached the Colorado line. It intercepted the great herds of longhorn cattle, being driven north from Texas to the Kansas Pacific Railway, at Abilene, and thereafter, for several years, such towns as Newton and Dodge City, Kans., were the great cow towns of the West, whence the cattle were shipped east.

Cattle were not native to America, and our first importation came with the De Narvaez expedition in 1528. These cattle were the longhorn, from the mountains of Spain, and came into Mexico by way of Santo Domingo. During the Civil War, both Northern and Southern armies depended on Texas for their supply of cattle for food, as that state was unmolested by either army. Millions of longhorn cattle were driven over the "Chisholm Trail" to the Santa Fe Railroad. By now the longhorn of Texas has practically disappeared and is fast becoming a legend.

MIGHTY BUILDERS OF AN EMPIRE

The Santa Fe Railroad took great pains with its colonization projects, chief of which was that of the Mennonites. Their story is a part of progressive American history. In its westward course this road reached the Coast in 1885. Similar romance surrounds the construction of the Northern Pacific and the Southern Pacific, both completed in 1883; the Denver and Rio Grande, the Great Northern, and finally the Milwaukee, completed in 1909 as the last of the continental lines.

The great era of railroad building, from the close of the Civil War to the end of the century, a period of 35 years, brought to the fore scores of outstanding engineers whose splendid lives and fine accomplishments have become history. To their clear vision and unswerving integrity and industry is due much of the credit and glory for the building of that great empire within a nation between the Mississippi and the Pacific.

One has but to close his eyes to see the panorama unfold: Lewis and Clark carrying the Union flag, steadfastly plodding their way to the Northwest by way of the Missouri River; fur hunters and traders bringing their pelts by bateau and canoe to St. Louis; pack trains slowly winding over prairie or through mountain passes; stagecoaches constantly in danger of hostile Indians; the Pony Express shuttling its way over 2,000 miles of trail; the Mormons' long trek from Council Bluffs to Salt Lake City; the thousands upon thousands who perished without benefit of clergy, on the Oregon, the Santa Fe, and the California trails; the great influx of homesteaders; the northern drives of cattle from Texas, along the Chisholm Trail; the gold rushes of the forties and fifties; the high romance of railroad building; the founding of villages and cities; and the welding of the parts into the whole. To this land of ours I would like to apply an old French proverb, which reads, "The more it changes, the more it remains the same thing." The United States has evolved in her transportation and other methods, but these sturdy people to whom we belong have not changed. They will go on in their high adventure of progress, with courage and daring for the future.

Although every phase of transportation progress, especially in the Far West, is portrayed in the literature of our nation, it is fragmentary as yet, and it will be an appalling task for any historian to weave it into a chronological whole. The time is ripe for such a work, and when it is written by a painstaking and impartial master of history, it will make a classic, a vivid epic of a great people, before which fanciful romance will pale into insignificance.

Preventing Disintegration of Cities

A Constructive Program Based on Economic and Engineering Principles

By Harland Bartholomew

Member American Society of Civil Engineers
Harland Bartholomew and Associates, St. Louis, Mo.

Unplanned expansion of cities and exodus of home owners from the central areas of municipalities to places "farther out" are leaving cities in a serious state of economic unbalance. If it is admitted that urban population growth cannot continue—as scientists and statisticians seem to agree—what is to become of the blighted central areas covered with obsolete improvements? Mr. Bartholomew believes the case is not hopeless if studies are undertaken at once to determine the total urban area required and its allocation to each city use, and if comprehensive city plans based on such studies are prepared, adopted, and put into effect. This article represents a shortened form of the paper read by Mr. Bartholomew before the National Conference on City Planning at Pittsburgh in November 1932.

Of all man's creations, the average American city is about the most wasteful. An increased debt structure and ever mounting taxes are manifestations of deep-seated economic ills. The unsatisfactory living conditions from which so much of the population has attempted to escape are plain evidence of low environmental standards. Both for this reason and because of unsound economic practices, our cities are faced with wholesale economic disintegration throughout most of their areas. Every large city in this country lost population in its central areas between 1920 and 1930. Typical of this condition was the city of St. Louis, which lost population in 38 per cent of its total area of 62 sq miles, all centrally located, in this short span of ten years. How long can our cities withstand such an economic shock? Disintegration of this character is doubly wasteful, for not only does it vastly increase the capital debt and overhead expenses to furnish public services in the newer outlying districts, but in the older central districts values are destroyed and revenues reduced while municipal services must be continued. This is a vicious circle of inestimable danger.

CAUSES OF DISINTEGRATION

The causes of disintegration may be listed as follows: low environmental standards in building development; unwarranted spread of the city, induced by new forms of transportation; exaggerated ideas of population growth; unbalanced design of the city resulting from improper arrangement and distribution of land uses; excessive speculation in real estate; and the individual's erroneous ideas of escape from the city and lack of community responsibility.

Since 1860 our cities have experienced a growth in population unprecedented in all history. The electric street car first increased the area of cities, and by the time they had more or less adjusted themselves to this new form of transportation they were hopelessly thrown out of balance by an additional expansion nine or ten times greater than ever before, due to rapid transit and the automobile. It has been assumed that rapid growth in population would somehow compensate for losses and maladjustments incident to enlargement of area. This is an erroneous premise, as will be shown. It is consequently difficult, if not impossible, to bring about any balanced design. Everything is without definite scale.

As a people we are quick to accept almost any form of change without stopping to consider its full consequences. The modern American city cannot be reorganized or reconstructed in any short space of time. Even with the advantage of all forms of modern devices for constructing buildings, highways, or whatever may be used in the city, there is no escape from the fundamental problems of cost. Someone must pay the final

TARGET
DOT
RED MAN

Typical Blighted District, to Be Found Within a Half Mile of the Business Center of Almost Any Large City
Such Buildings Make No Return on the Owners' Investment

FOR SALE or LEASE

Properties Such as This in Central Districts Have Been Sacrificed in Great Numbers
Occupants Have Moved "Farther Out"

bills. If we but stop to consider these final costs there will be less haste in accepting instruments or theories which involve sweeping changes in methods of city building and instead we will give more consideration to balanced design and proper housing standards. Thinking and planning cost little and when carefully and wisely done save untold waste in money, in time, and in human health.

SOME OF THE CAUSES FOR DECENTRALIZATION

Obsolete Dwellings, Shoddy Stores, and Restricted Living Conditions

Somehow the impression has been created that, as individuals, we can escape from the city. There has been no personal sense of responsibility to the community. If growth were forever unlimited, the individual might ultimately escape the consequences of extravagant, unplanned growth. If there are definite limits to growth, however, as now appears evident, the case is entirely different. We are all caught in the same squirrel cage, and each must adjust himself to the situation. This can be done to best advantage by placing community interest and responsibility above individual interest.

It is impossible here to do full justice to the effect on the present city of decentralization and regionalism, but these factors cannot be ignored. Decentralization in practice appears to mean the moving of population from the centers of cities to the outskirts, and the distribution of stores and shops throughout the whole urban area. As now practiced, it is economically wrong, more or less destructive in fundamental character, and may ultimately produce environmental disadvantages as great as those found in the centralized city.

The present form of city growth, which we may refer to as "centralized," is more in keeping with the principles of economics and social science than seems to be generally realized. The difficulties which are found in the present structure or form of the American city are more the result of abuse and lack of control than of faults peculiarly inherent in the form itself.

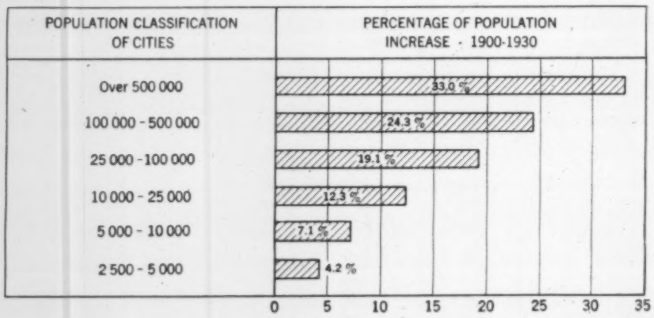


FIG. 1. INCREASE IN URBAN POPULATION RELATED TO THE SIZE OF CITIES

Are we really at the end of the industrial era? Can our urban population be transformed to a predominantly rural or agricultural one in any short period of years? Even granting the superior advantages of the automobile, the radio, the septic tank, giant power transmission systems, and the home electric plant, is it probable that these can quickly transform the social order? After all, man is a gregarious animal. He likes the modern city. He will even be satisfied with a lower economic status and be content to remain where he is, particularly if his living conditions can be improved somewhat, for the sake of retaining many of the advantages he now enjoys in the modern American city.

In all the literature recommending decentralization there appears no discussion of the economic consequences of abandoning our present city structures or of the economic disadvantages that may be inherent in a new mode of decentralization or its mystic companion, "regionalism." To face frankly the difficulties and abuses common to present methods of city growth, and to make an honest attempt to correct them, is a far wiser course of procedure than to launch suddenly upon a new, uncharted, and unexplored course. Under any new system of procedure there will be the same old set of speculators and exploiters, but they will have newer and wider fields of operation. Under present methods of growth they are becoming more closely restricted and their modes of operation more definitely appraised and controlled.

The location of the modern American city is based on a sounder interpretation of economic geography than has yet been proposed. The great majority of our cities have been located at strategic points on oceans, lakes, and rivers. Water transportation has been, and probably will again become, such an economical form of transport that it cannot be ignored. It may even become of greater significance in future years as basic economies inevitably assume greater and greater significance. Our railroad transportation system exerted a certain influence on the distribution of the urban population, but it did not change the form of the modern city. The automobile, the motor truck, and the motor bus have played havoc with street car and railroad systems but, again, they have not substantially changed the basic form of the centralized city.

PREVENTATIVE MEASURES PROPOSED

This form is fundamentally right both from an economic and from a social viewpoint; the present difficulties are the outgrowth of various abuses, principally speculative in character, and are not inherent in the form. There is far more fundamental economy to be achieved by city planning than by the arbitrary slashing of municipal budgets in the interest of immediate expediency. Whatever is extravagant and wasteful should be eliminated at once but municipal expenditures can be reduced only to a certain point, or fundamental needs will be neglected. Beyond this point further economy can come only as the result of a more efficient design of the whole, which hence becomes capable of more economical operation.

What then are the remedies needed to prevent the disintegration of American cities? They are: (1) a careful estimate of the total population to be provided for in the next 30 to 50 years; (2) a scientific determination of the total area required for urban purposes; (3) a plan for the most appropriate location and distribution of industrial, commercial, and residential areas; (4) a plan for the most desirable distribution and density of the population; (5) official adoption of comprehensive city plans; and (6) reconstruction of decadent central areas.

Practically all these remedies, No. 6 excepted, are fundamentally matters of conservation involving or requiring no increase in the municipal debt. Several authorities appear to approach agreement that our population will probably reach a maximum of 150,000,000 people about 1960. If this prognostication is anywhere near correct there is only a very short period in the life of the city in which to make the adjustments necessary to produce the most economic form of city structure. The idea, previously universal, that there is no limit to the growth of the city—which consequently became "just a vast speculation in real estate" —no longer can be accepted.

Fine Homes Prematurely Abandoned

A Result of Wasteful Urban Decentralization and the Unfortunate Type of Surrounding Developments

A stable population of 150,000,000 people in 1960 represents an average increase in total population of only about 20 per cent, or approximately 25,000,000 people. However, it would not seem advisable to assume an average ultimate population increase of 20 per cent for each city, because we know that cities of different sizes and different geographical location have increased in population in varying degree. An examination of the census figures for the past 30 years reveals the very significant fact that cities have increased in population in direct proportion to their size, as shown in Fig. 1. This increase has also varied with geographical distribution, from 27.0 per cent in the Middle Atlantic Section to 2.4 per cent in the Mountain Section, as shown in Fig. 2.

Table I. Average Uses of Land in Some American Cities in Percentage of Their Area

Use	Area	Total Area
Dwellings:		
Single-family dwellings	36.1	
Two-family dwellings	2.1	
Multiple dwellings	1.1	
Total		39.3
Commerce		2.4
Industry:		
Total industry (average in 16 cities)		10.8
Light industry (average in 14 cities)	3.2	
Heavy industry (average in 11 cities)	2.7	
Railroads (average in 11 cities)	5.5	
Streets		33.6
Parks		6.3
Public and semi-public uses		7.6
		100.0

Based on the two factors of size and geographical distribution, it is possible to make an estimate of growth for each individual city for the next 30 years. Certainly such an estimate is a far saner basis for economic planning than assumed unlimited growth of cities, or any new mode of growth, or the mere following of a policy of laissez-faire. In some cases a growth of 5 per cent would be estimated, in others that of 30 per cent, but in no cases 200 or 500 per cent.

There being a definite limit to the increase of population in any city, would it not be the very essence of economy to determine how much area will really require sewerage, water, paving, and various other municipal services, rather than to scatter these facilities indiscriminately over wide areas in response to the demands of real estate speculators? A careful study of the total area of land actually developed and used for various city purposes discloses the fact that in cities of from 5,000 to 300,000 population there is a total average of 6.9 acres used for urban purposes by each 100 persons.

WASTEFUL PRACTICES

Industrial, commercial, and residential uses continue to expand over larger and larger areas, regardless of necessity, apparently actuated partly by motives of speculation and partly by the idea that new pastures are always greener. Even though zoning has come into use to check the worst of these practices, it can only be effective in bringing about a strong economic and social structure where there is a definite estimate of population growth and a well defined area of growth, in which appropriate sections are allotted to each use and all the uses are so arranged as to function together most effectively and satisfactorily.

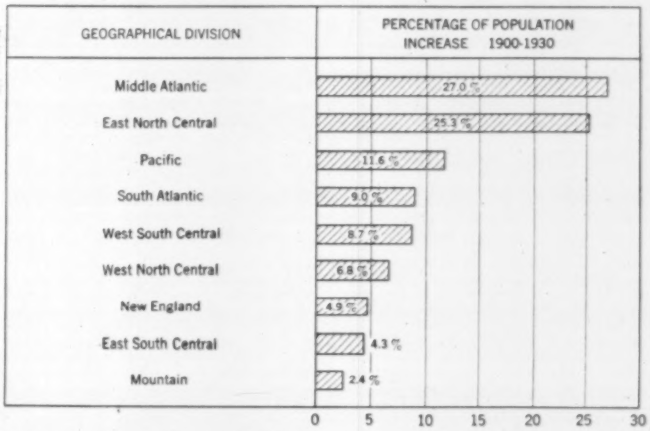


Fig. 2. Increase in Urban Population According to Geographic Distribution

If arbitrary municipal boundaries are ignored, it will be found that the total amount of each general land use is fairly constant, even in communities of divergent character, size, and location. In a number of self-contained cities, the use of land was divided as shown in Table I. By means of such a classification, adjusted to suit local conditions and supplemented by reasonable estimates of growth and a proper taxation system, it should be possible to design an efficient and desirable city.

The speculative debauchery in city real estate has surpassed the excesses of the stock market, but it is as yet scarcely appreciated or understood. The blocks and blocks of vacant and obsolete property, industrial as well as residential, constitute an ever increasing burden of overhead expense. Our cities are too much like an apple that is firm and attractive on the outside but is slowly decaying around the core.

UNIVERSITY HILLS AND UNIVERSITY PARK, ST. LOUIS
All Improvements Installed by Subdivider and Their Cost Included in the Purchase Price

Only about one-tenth of the total frontage of the whole main thoroughfare system can ever be absorbed for commercial purposes. Despite this fact, most such frontage is still considered as commercial and owners usually insist that it be so zoned. Only about one per cent of a city's area can be absorbed for multiple dwellings. Nevertheless, these structures are usually permitted to invade single-family dwelling areas with the result that they help to blight about ten times as much property as they can absorb. Observations in the average American city will bear out this conclusion.

Commercial and multiple-dwelling uses combined cannot absorb 5 per cent of a city's area, and yet a large percentage of every city is usually subjected to speculation for these two uses. To pursue this practice is to invite the blighting of property values on a very large scale.

DESIRABLE DENSITY AND DISTRIBUTION OF POPULATION

Except for a few high-class subdivisions and a few philanthropic housing developments which, taken together, accommodate an exceedingly small and insignificant percentage of the total population, the residential districts of American cities are devoid of conscious design or adequate regulation for the establishment of a satisfactory standard of living. Since the subject has never been considered, it is difficult to suggest what might be a desirable distribution and density of population. It will vary, of course, because of different conditions in various parts of the country and it will vary in each individual city according to certain types of housing found to be most desirable under normal conditions for persons of varying income. No satisfactory answer to the question can be given until there has been much more study in the field. We need to know not only the location and size of areas occupied by houses which fall below decent standards, but the desirable character and location of houses for persons in the various income classifications.

Zoning is practically the only element of comprehensive city planning that has yet assumed official status. Only a few cities, such as Cincinnati, have officially adopted comprehensive city plans. All phases of such a plan should be given an official status in all municipalities, as contemplated by the standard city planning act published by the U.S. Department of Commerce.

In the past, city plans have been too timidly conceived and too ineffectively advanced. There is no longer an excuse for incomplete or ineffective planning, however. By experience we have learned the technology of detailed design and have come to understand much more definitely the laws of supply and demand in urban real estate. The probable volume of growth can at least be anticipated. The next decade will probably witness an official adoption of comprehensive city plans as widespread as has been the adoption of zoning ordinances in the past 10 or 15 years.

So many of us have been trying to move out of the central sections of cities that municipalities are becoming economically unbalanced. They lose population and tax returns in the central areas, and collect insufficient taxes to pay the cost of the new developments on the outskirts. The total cost of this process of burning the candle at both ends is just beginning to be realized. We cannot afford to continue this wasteful course of urban growth.

REBUILDING CENTRAL AREAS

In the rebuilding of central areas the fundamental difficulty is the extremely influential factor of environment. Reconstruction consequently can take place only when it is done on a sufficiently large scale to enable the new development to create its own environment. The size of the area cannot be arbitrarily determined; it must always depend on local conditions. This type of improvement was much discussed at President Hoover's Conference on Home Building and Home Ownership and was anticipated by the slum clearance provision in the relief bill sponsored by Senator Robert Wagner, authorizing the Reconstruction Finance Corporation to make loans for such purposes. Such a loan has already been approved for a slum clearance project in New York City.

Reconstruction in these central areas should be undertaken in accordance with some definite population pattern. There should be a housing plan for the whole community so that reconstruction in the central areas, particularly where municipal subsidies are provided, will not be just another speculation in real estate competing with housing developments of similar type that were previously constructed without the advantage of a municipal subsidy. If we cannot find ways and means of arresting this type of blight, the inevitable losses in these areas, added to the losses of unrestrained expansion, will soon produce a real economic crisis in all city real estate.

Resistance of Sheet Piling to Overturning

Results of Experimental Work on Bulkheads and Some Suggestions for Their Design

By DIMITRI P. KRYNINE, M. AM. SOC. C.E., *and* ROBERT W. ABBETT, ASSOC. M. AM. SOC. C.E.
RESEARCH ASSOCIATE IN SOIL MECHANICS AND INSTRUCTOR IN CIVIL ENGINEERING, RESPECTIVELY, YALE UNIVERSITY, NEW HAVEN, CONN.

MODELS of sheet piling used as a retaining wall or bulkhead have been recently employed in a series of tests undertaken at Yale University. This article includes a record of the experiments, an analysis of the results, and some preliminary conclusions, which may be applied in the actual design of walls to be constructed in sandy soils. The experiments revealed the necessity for further research, and the present article may be considered as descriptive of an initial stage of experimentation along these lines. This research has been carried out through the cooperation of the Society's Research Committee on Earths and Foundations.

INSUFFICIENCY of information on sheet piles, acting singly or together as a retaining wall or an anchored bulkhead, prompted the experimental work described in this article. A familiarity with the behavior of such construction when tested to failure will enable the making of more adequate designs. In this discussion elastic deformation of the pile itself is assumed to be negligible.

When a vertical pile (Fig. 1) is pulled by a horizontal force, F, it is supposed to rotate first about a center or "zero point," O_1, located on the pile itself, at about two-thirds the depth, d, to which the pile is driven. The location of the point O_1 may be found more accurately by using mathematically complicated formulas. When the angular displacement, α, reaches a certain value, depending on the capacity of the soil to be compressed, the center of rotation moves to the surface of the ground, and finally a conic body, C, is pushed out. Thus the pulling force, F, is transformed into shearing stresses along the surface of the earth cone. When the depth of driving, d, increases, the lateral surface of the cone, C, increases proportionally to the square of d. Thus, the resistance of a pile to a horizontal force should be practically proportional to the square of the depth of driving. Obviously, if the depth of driving, d, exceeds a certain limit, the pile would be broken without pushing out an earth cone.

A long row of unanchored sheet piles, termed a "free wall" in this article, is nothing but a series of individual piles placed close together. Such a wall rotates about the center, O_1 (Fig. 1), in the same way and under the same circumstances, as an isolated pile. Owing to the restricted movement of the compressed soil, however, the angular displacement preceding the destruction of the soil by shear is much smaller than in the case of isolated piles. According to our experiments, α is generally less than 10 deg in the case of sand. Furthermore, the shearing resistance, as developed in a plane, is proportional to d to the first power only.

If a point, O_2, of a free wall should be fixed by a tie-rod and an anchor, the free wall would become an anchored sheet-piling wall, termed a "bulkhead" in this article. If the anchorage of a bulkhead fails, the structure resumes the properties of a free wall, that is, it will rotate about the point O_1.

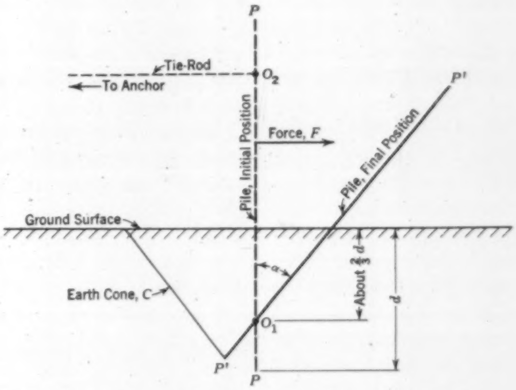


FIG. 1. ACTION OF A BULKHEAD AS COMPARED WITH THAT OF A SINGLE PILE

For one series of tests, a galvanized iron box, 36 by 16 by 18 in., was filled with sands of different moisture content, varying between 6 and 15 per cent by dry weight. Two similar models of sheet piling were used: first, a metal plate 18 by 10 by $^1/_4$ in., and second, an assemblage of five wooden sheet piles joined at the top by two stiffeners. No essential difference in the action of the metal and wooden models was found. With an ordinary heavy hammer the models were driven into the soil to depths varying from 6 to 8 in. In each of the experiments, which totaled more

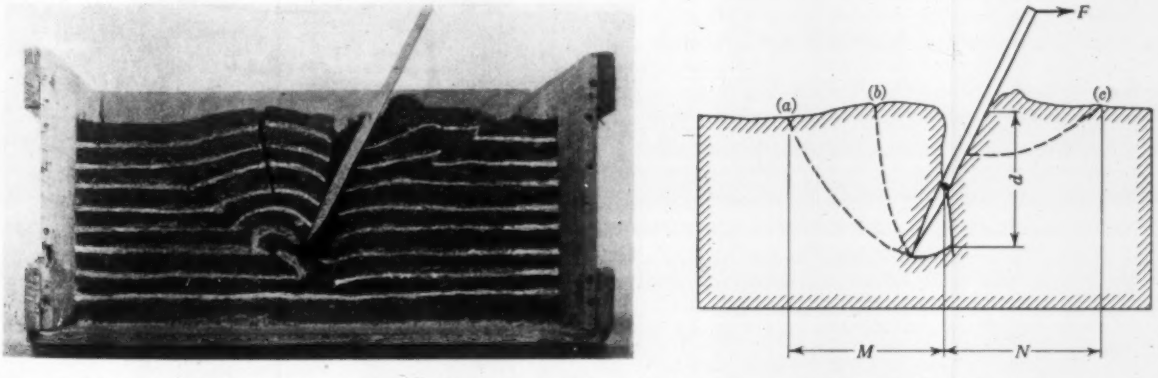


FIG. 2. SHEARING ACTION OF A SHEET PILE; RESULT TYPICAL OF A HUNDRED EXPERIMENTS
Showing Occurrence and Location of the Three Master Cracks, *a*, *b*, and *c*. Distance M Varies from d to $1.5\,d$, and Averages $1.2\,d$; Average Distance N Is $0.8\,d$; Crack *b* Is Usually Halfway Between Crack *a* and the Final Location of the Pile

than one hundred, the pulling force was gradually increased and measured.

The same action on a somewhat smaller scale is represented in Fig. 2. This experiment was performed in a wooden box using alternate layers of yellow and white sand. When cracks appeared on the surface of the soil a longitudinal wall of the box and half the soil were removed and a photograph was taken. The photograph in Fig. 2 shows the results that were characteristic of all the experiments. Three master cracks may be seen on the surface of the soil: a forward sliding crack, *a;* a bursting or tension crack, *b;* and a backward sliding crack, *c*. Hereafter these will be referred to as cracks *a*, *b*, and *c*, respectively. Cracks *a* and *b* usually appear almost simultaneously; sometimes, however, the crack *b* does not appear at all. This is true in the case of cohesive and well packed soil material.

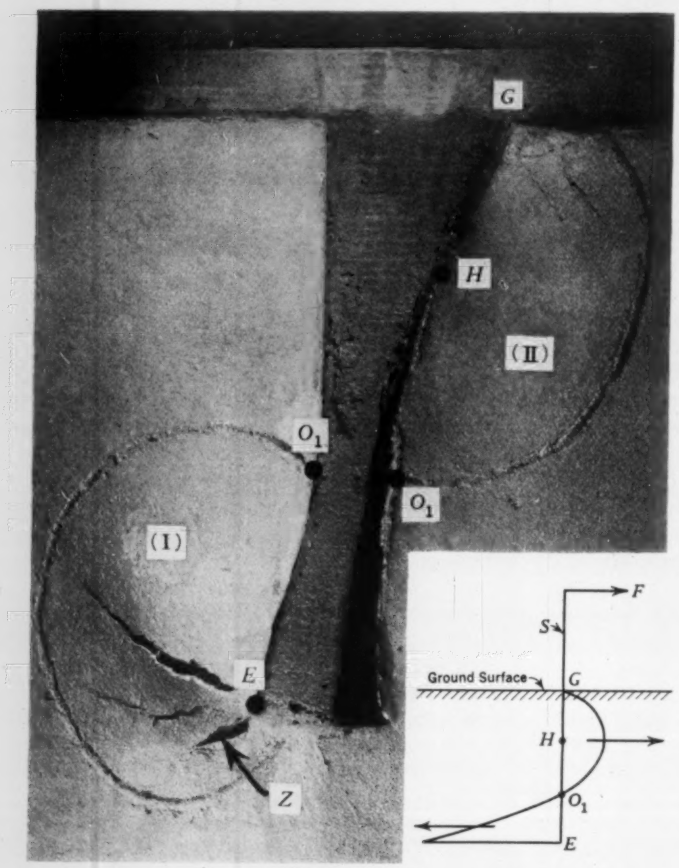


FIG. 3. MODEL OF SHEET-PILING ACTION AT AN EARLY STAGE OF DESTRUCTION OF THE SOIL MASS

Inset Shows a Theoretical Stress Diagram

RESULTS OF TESTS EXPLAINED

The action begins by compression of the soil. A theoretical compression stress diagram, as usually assumed, is shown in the insert in Fig. 3. The photograph in Fig. 3 illustrates an initial stage of destruction of the soil mass in a sheet-piling model. In this test a metal plate, introduced into a horizontal layer of wet silty sand $^3/_4$ in. thick, was pulled by a horizontal force and was afterwards removed from the soil mass.

It should be noted that there are two bulged zones, *I* and *II*, bounded by the curves traced for greater clearness on the soil surface. These zones correspond to the compression zones below and above the point of rotation, O_1. The shearing cracks seen on the photograph reveal points of either maximum stress or minimum soil resistance. The former is the case for the cracks at the bottom, *E*, and the latter for those at the top, *G*. It may be concluded that crack *a*, shown in Fig. 2, does not form all at once, but is the result of a progressive failure, at least at the initial stage of its formation.

Closer examination of the photograph reveals also two systems of shearing cracks at *G*, forming equal angles with the direction of the compressive stress. The resultant of the compressive stresses is assumed to act at *H*, although no crack may be seen there. The backward sliding crack *c*, shown in Fig. 2, appears somewhat later, when the top of the layer is already weakened by shear strains. As a rule, besides the master crack, *c*, there are two or three other parallel cracks and a corresponding number of mutually parallel shearing surfaces. Both the crack *Z*, in Fig. 3, and the upfolding of the sand layer close to the bottom of the model in Fig. 2, are due to the violent action of the sheet pile at that point, which causes a kind of turbulent movement in the interior of the soil mass.

If the surface O_1E, in Fig. 3, were uniformly loaded, shearing surfaces would form along it. But, owing to overloading at the point *E*, yielding occurs at that point only. Subsequently the pressure is transmitted to the soil mass through the compressed zone *I*, and finally a prism is pushed out accompanying the formation of the crack *a*. Data concerning the location of cracks *a* and *c* are given under Fig. 2.

OTHER EXPERIMENTS CONDUCTED

Additional experiments, in which the soil was superelevated on one side of the sheet pile, show that the location of cracks *a* and *b* are not greatly different from those where both surfaces are at the same elevation. This is probably due to the curved shape of the shearing surfaces. In some of the experiments the crack *a* did not appear at all, and in these cases failure of the wall was accompanied by the formation of cracks *b* and *c* only. This happens when the pile has a very shallow penetration, which should be avoided in practice.

Another series of experiments was made in order to study the influence of the interval between the sheet piles. The resistance against overturning of a single wooden sheet pile driven in a certain sand to a depth of 8 in. was 18 lb. Yet a set of five piles in the same material produced a resistance of but about 50 lb. Using

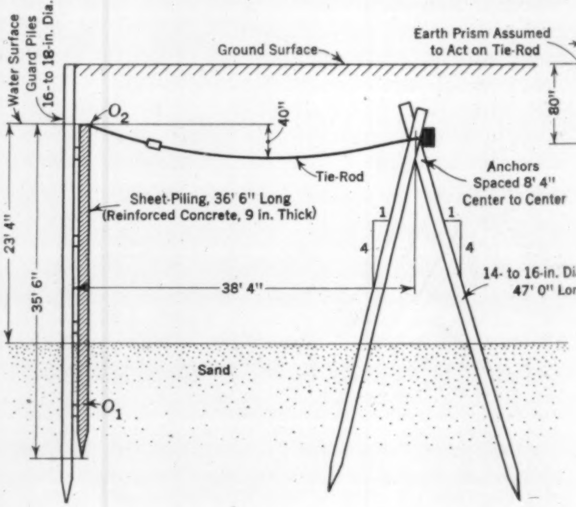

Water Surface
Guard Piles 16-to 18-in. Dia.
Ground Surface
Earth Prism Assumed to Act on Tie-Rod
30"
80"
O_2
40"
Tie-Rod
Anchors Spaced 8' 4" Center to Center
Sheet-Piling, 36' 6" Long (Reinforced Concrete, 9 in. Thick)
1
1
4
4
23' 4"
35' 6"
38' 4"
14- to 16-in. Diameter 47' 0" Long
Sand
O_1

FIG. 4. ANALYSIS OF A BULKHEAD FAILURE AT INDUSTRY HAVEN, STETTIN, GERMANY

Evidenced by Bulging Wall and Sagging Anchor Tie-Rod two extreme piles of the set, representing 40 per cent of the length of the wall, the resistance was 35 lb, or 70 per cent of the resistance of the set of five. This phenomenon is easily explained by the difference in resistance of isolated piles, as previously explained. It is analogous to the fact that the bearing capacity of a single pile, as far as vertical loads are concerned, is unreliable when applied to a group unless the piles are properly spaced.

TWO FAILURES DISCUSSED

The tie-rod of a sheet pile wall in Industry Haven, Stettin, Germany, shown in Fig. 4, was bent and the wall itself bulged, although this bulging is not shown in the diagram. The failure is attributed by Dr. Ing. H. Cantz, in *Der Bauingenieur* for July 15, 1932, to lack of intermediate support in the middle of the span of the tie-rod. Under the circumstances, such a support actually was necessary. There are, however, no signs of free wall action in this case; in other words, there are no signs of outward movement of the point O_2. Otherwise, according to Fig. 2, the tie-rod should have bent upward and not downward. Therefore the wall acted as though anchored, at least partially, and the failure of the structure was probably due to the insufficient rigidity of the wall. When the wall was repaired, its thickness was somewhat increased.

The diagram in Fig. 5 represents a steel bulkhead in Connecticut, formed of spaced steel master piles with five shorter piles in each interval. The tie-rods are fixed to the tops of wooden anchor piles. Failure of the structure on a part of its length, resulting in a deviation in the alignment of 3 ft 1 in., was probably due to failure of the anchorage. Apparently the bulkhead behaved as a free wall. The crack a appeared at 30 ft 8 in., and the crack b at 18 ft 3 in., from the final position of the wall. The depth of driving was 32 ft. In one of the illustrations the crack a can be slightly seen. The crack b was about 3 ft wide and very similar to that represented in Fig. 2(*A*).

SOME DESIGN SUGGESTIONS

The facts that have been discussed reveal the necessity for further research in this field. A mathematical theory applying to the location of cracks a, b, and c, should be elaborated. The physical nature of the process of crack formation should also be determined, since these experiments suggest the possibility of gradual penetration of the shear crack into the soil mass, at least at the beginning of the process. Unless this is the case, a simultaneous failure along the whole shearing surface may be considered probable. Experiments should also be made with plastic soils, particularly mud.

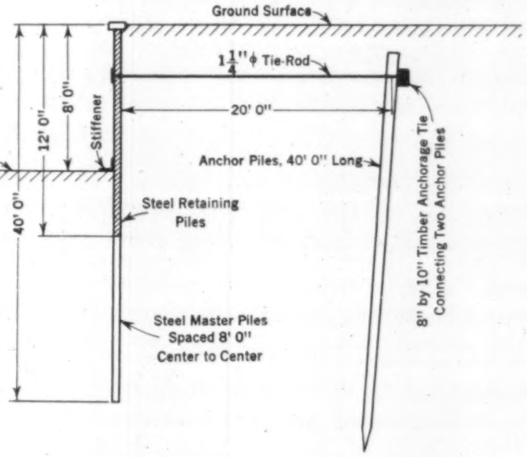
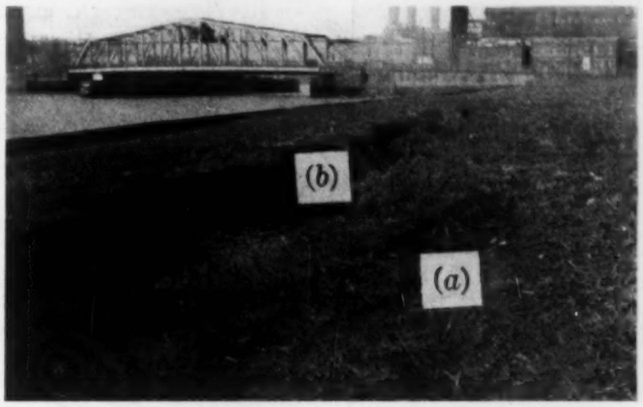

Ground Surface
$1\frac{1}{4}$" ϕ Tie-Rod
20' 0"
12' 0"
8' 0"
Stiffener
Ground Surface
Anchor Piles, 40' 0" Long
40' 0"
Steel Retaining Piles
Steel Master Piles Spaced 8' 0" Center to Center
8" by 10" Timber Anchorage Tie Connecting Two Anchor Piles

Fig. 5. Analysis of the Failure by Rotation of a Bulkhead in Connecticut

Probably Due to Failure of Anchorage

The following suggestions for the design of sheet piling in sandy soils are merely deductions from the preceding discussion:



The Connecticut Bulkhead Analyzed in Fig. 6

Anchor Piles Are Too Close to the Wall; Cracks a and b Were 30 Ft and 18 Ft, Respectively, from the Bulkhead

1. The anchor should be located as far as possible from the wall, beyond the eventual crack a, that is, roughly, at a distance of d to $1.5d$, where d is the depth to which the pile is driven.
2. The anchor should not be designed in the form of a single pile or similar structure likely to rotate in the interior of the soil mass. The closer the tie-rod is to the center of the anchor, the better. In this connection, anchor plates seem to be preferable to anchor piles.
3. Long tie-rods should be designed with an intermediate support to prevent sagging.
4. The depth of driving should be such as to reduce to a minimum the consequences of a catastrophic failure of the anchorage. Such a failure is followed by an angular displacement of the sheet piling, caused first by the breakdown of the compressive resistance and afterwards by the breakdown of the shearing resistance. Although angular displacement due to compression cannot be avoided, it is evident that the unit shearing stresses along the surfaces indicated by the cracks a and c may be decreased by increasing the depth of driving. Owing to the insufficiency of our theoretical knowledge, however, the formulation of any definite rule on this subject would seem impossible at the present time.
5. It is not necessary to drive all the sheet piles to the full depth. Instead, an arrangement of shorter intermediate piles between the master piles may be used successfully. The intermediate piles should reach the point where the crack c starts, that is, approximately one-third the depth of driving. Longer intermediate piles add nothing to the strength of the wall and shorter ones are inadequate. Theoretically speaking, the spacing between the master piles should be such as to permit the full development of the shearing surface of each pile without overlapping and thus make the surrounding earth mass work to its full strength.

ACKNOWLEDGMENT

The experiments described were made with the financial help of the Society's Committee on Earths and Foundations, of which Lazarus White, M. Am. Soc. C.E., is chairman.

Flow in River Bends

Recent Experiments on a Mississippi River Model Discredit Helicoidal Theory of Flow

By HERBERT D. VOGEL, ASSOC. M. AM. SOC. C.E.
FIRST LIEUTENANT, CORPS OF ENGINEERS, U.S. ARMY; DIRECTOR, U.S. WATERWAYS EXPERIMENT STATION, VICKSBURG, MISS.
and PAUL W. THOMPSON
SECOND LIEUTENANT, CORPS OF ENGINEERS, U.S. ARMY; ASSISTANT DIRECTOR, U.S. WATERWAYS EXPERIMENT STATION

A SERIES of large-sized outdoor models of various bends on the Mississippi River have been built and operated by the staff of the U.S. Waterways Experiment Station. An analysis of the data obtained reveals the necessity of applying a new theory for the movement of bed material. Surface floats and dye were used to determine the direction of surface and bottom currents. Quite by chance it was discovered that the bearded grains of oats formed an ideal indicator of the direction and manner of the movement of bed load, and the direction of the current itself. Bed material was found to move toward the convex side of a bend, although there was no definite flow of water in that direction. The impossibility of using the commonly accepted theory of helicoidal flow to explain this phenomenon leads the authors to accept the more recent theory for movement of bed material by turbulences of the water in the direction of decreasing velocity.

CONCLUSIONS based on observations of flow in natural water courses are often misleading, if not actually in error, for the reason that the data observed are insufficient to explain completely the causes of the phenomena in question. Where a single phase of action is noted without obtaining positive information as to the primal causes, it is frequently necessary to develop by hypothesis the underlying motive powers and directive forces of nature. Since critical data are generally the least easily procured, the facts pertinent to the development of a true explanation may be improperly weighted or even entirely neglected.

Probably the most dangerous element in the formulation of such an important hypothesis is the fact that it has been based on observations of nature and hence is nearly irrefutable. This general acceptance of observed data as prima facie evidence of the truth of hypothetically deduced laws is regrettable, of course, but until instruments can be devised for fuller and clearer determination of basic facts and properties, the procedure of scientific thought must be along stumbling paths. Fortunately, it is not necessary to assume defeat. As the medical profession has its laboratories and X-rays and the structural engineer his strength-testing machinery, so the river engineer now has all the principles and facilities of model research at his disposal, practically without limitations.

HELICOIDAL THEORY OF FLOW AT BENDS

The phenomena commonly noted at a river bend offer a case in point and illustrate the hazards of inductive reasoning. Most frequently cited in this connection is the existence of a steep and often caving concave bank, opposite to a gently sloping convex bank that is continually built outward and downstream by the deposition of bed material upon it. Now from a purely theoretical standpoint, and without recourse to much definite information as to fundamental causes of sand-bar formation, it might be reasoned that the swiftest velocities should occur against the convex bank, where distances are shorter and slopes are greater, and that therefore greater erosion and greater depths should be found on that side of the bend.

Apparently perplexed by this line of thought, Prof. James Thomson, in March 1876, in the *Proceedings* of the Royal Society of London, published a statement that "... a stream flowing along a straight channel and thence into a curve must flow with a diminished velocity along the outer bank, and an increased velocity along the inner bank, if we regard the flow as that of a perfect fluid. In view of this principle, the question arose to me some years ago: Why does not the inner bank wear away more than the outer one?"

To explain the apparent discrepancies between theory and fact he then proceeded to develop a theory of helicoidal flow around river bends. This theory, which has gained wide acceptance, conceives of water as flowing down the concave bank, across the bottom to the convex bank, up the convex bank to the surface, and across to the concave bank again, all at the same time that the water is also moving down the slope of the stream. This theory is substantiated by the observed paths of surface floats, which tend to cross to the concave side of a bend, and by the observed fact that bars are built on the convex side of the bend, indicating that the material from the caving concave banks crosses to be deposited on the convex side. Furthermore, the theory can be justified mathematically and mechanically by a consideration of the action of centrifugal force on a mass of water flowing around a bend at varying velocities. The theory completely and satisfactorily explains the phenomena of river bends, in so far as these phenomena are susceptible to explanations gained from ordinary observation.

The researches of the U.S. Waterways Experiment Station are concentrated largely on a great alluvial stream, the Mississippi River, many bends of which have been reproduced at the station in models on various scales. These models, susceptible to delicate adjustment and control, to exact measurement, and to accurate and complete observation, are ideally adapted to the study of natural stream flow phenomena. As such, they have resulted in the discovery of no hitherto unsuspected natural laws and have offered no contradictions to the great fundamental concepts of hydraulics. However, they have provided a more accurate and complete picture of what really happens in a turbulently flowing watercourse than can be drawn from the stream itself. Among other things, they have thrown additional light on the subject of flow around bends.

In Fig. 1, the sketch shows the data secured from observations of flow in a model of Slough Bend, 60 miles below Cairo, on the Mississippi River. The model, which was a typical one, was built to a horizontal scale of 1:600 and to a vertical scale of 1:150.

It was an integral part of a model of the Island No. 9 reach of the Mississippi River and it functioned in solving the problem of that reach in an eminently satisfactory way. The data presented were taken in connection with the routine studies for the Island No. 9 reach,, and it is certain that they are accurate and complete beyond anything which could be practicably obtained from the natural stream.

Model of Slough Bend in Operation
Scale of Model Is 1 : 600 for Length and 1 : 150 for Depth

An understanding of how the data presented in Fig. 1 were obtained is necessary to their intelligent analysis. The bed of the model was of concrete and was marked out in grid lines so that positions could be quickly and accurately spotted. The lines indicating the movements of floats were obtained by plotting the course of chaff, confetti, wood chips, and other floating objects. The directions of the bottom currents, as indicated by the broken lines, were obtained by the use of dye, formed by dissolving flakes of potassium permanganate in the water. Successive injections of the dye were made along each line to minimize the uncertainty resulting from the diffusion of the dye in the turbulent water.

The important consideration in the compilation of data such as these is the means used to simulate the movement of bed material and to obtain the direction of currents near the bottom. In addition to dye, this laboratory is using, with excellent results, another device by which the directions of bottom currents and of bed load can be shown simultaneously. This device is nothing more than the ordinary oat grain, the peculiar properties of which were discovered here some time ago in the course of an investigation designed to find a material that would suitably simulate a caving bank. It was thought that oat grains, when mixed with a graded sand, would act as a binder and prevent the undue sluffing of the wet sand. Once washed from the caving bank, some grains were observed to sink to the bottom and to assume there the position illustrated in Fig. 2. That is, the heavy end of the grain was dragged along the bottom, while the bearded lighter end swung up in the stream and, by its position, indicated the direction of the current. Its action was thus exactly that of a wind vane. The oat grain, by

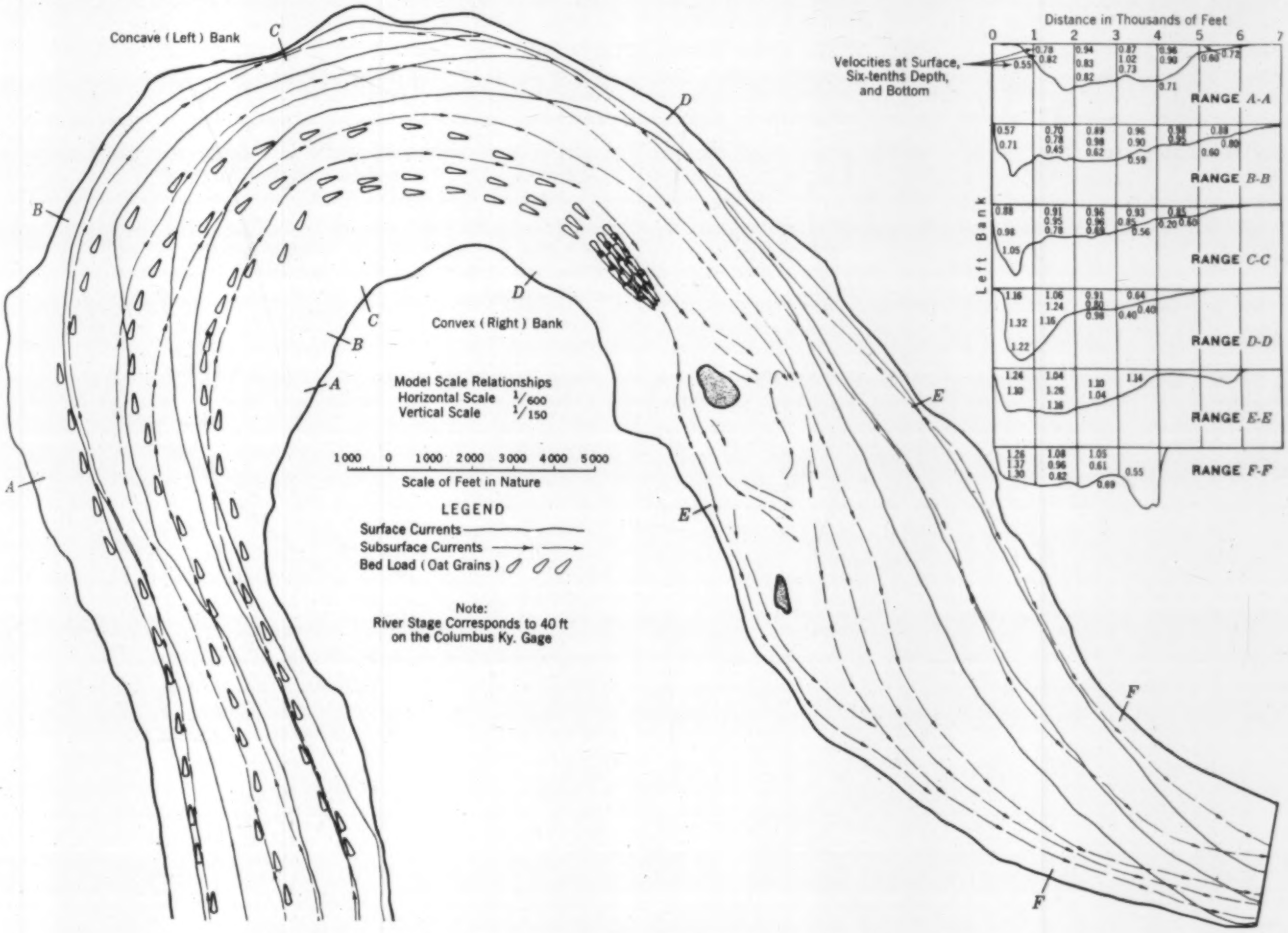

Concave (Left) Bank
Convex (Right) Bank
A
B
C
D
E
F
Model Scale Relationships
Horizontal Scale 1/600
Vertical Scale 1/150
1000 0 1000 2000 3000 4000 5000
Scale of Feet in Nature
LEGEND
Surface Currents
Subsurface Currents
Bed Load (Oat Grains)
Note:
River Stage Corresponds to 40 ft on the Columbus Ky. Gage
Distance in Thousands of Feet
0 1 2 3 4 5 6 7
Velocities at Surface, Six-tenths Depth, and Bottom
Left Bank
0.55 0.78 0.82 0.94 0.83 0.82 0.87 1.02 0.73 0.96 0.90 0.71 0.60 0.72
RANGE A-A
0.57 0.71 0.70 0.78 0.45 0.89 0.98 0.62 0.96 0.90 0.59 0.88 0.60 0.80
RANGE B-B
0.88 0.98 1.05 0.91 0.95 0.78 0.96 0.85 0.93 0.56 0.85 0.20 0.60
RANGE C-C
1.16 1.32 1.22 1.06 1.24 1.16 0.91 0.80 0.98 0.64 0.40 0.40
RANGE D-D
1.24 1.30 1.04 1.26 1.36 1.10 1.04 1.14
RANGE E-E
1.26 1.37 1.30 1.08 0.96 0.82 1.05 0.61 0.69 0.55
RANGE F-F

Fig. 1. Model of Slough Bend on the Mississippi River, Mile 58 to 67, Below Cairo, Ill.
Direction of Flow and Movement of Bed Load Indicated

its physical movement, indicated the direction and manner of the bed movement, and by the position of its free-swinging bearded end it showed the direction of the current at that particular point.

The data presented in Fig. 1 can now be intelligently considered. Examining the paths of the surface floats, it is seen that they invariably swing in near the concave bank, exactly as is frequently noted in nature. It is to be further noted that the floats tend to drift to the regions of high surface velocities. In contrast to this distinct crossing of the surface floats, the paths of the bottom currents, as indicated by the dye, are seen to remain essentially parallel to each other and to the bank lines. These data, which might be considered as inimical to a condition of helicoidal flow, might be discounted because of the inherent difficulties of tracing currents by means of dye It is here that the oat grains contribute their important evidence.

MODEL OF SLOUGH BEND, LABORATORY BUILDING IN BACKGROUND
At the U.S. Waterways Experiment Station, Vicksburg, Miss.

The oat grains were seen to drift across to the convex side of the bend. The movement was, in fact, not continuous or uniform, but was jumpy, rolling, and sporadic, exactly as the movement of sand on the bed is observed to occur. This is not surprising, since each movement is the result of the same forces, that is, the tractive effect of the flowing water and the impulses received from turbulence. The important point to be noted here is the direction of the currents, as indicated by the grains in their progress across the bed. Invariably these grains revealed a direction of flow parallel to the banks—exactly as shown by the dye.

It can be further noted that the grains tended to move toward the regions of low velocity. From these two facts it appears logical to draw the conclusion that, although bed materials are moved bodily across the bed, still the bottom currents do not cross with them, but remain, rather, parallel with the banks.

This conclusion implies that bed material is not swept across the bed by currents flowing in that direction. Another explanation is therefore necessary, which must take cognizance of the fact that surface floats do cross to the concave side. An explanation of the movement of bed material is conveniently offered by Prof. John B. Leighly of the University of California, in his recent paper, "Toward a Theory of Morphologic Significance of Turbulence in the Flow of Water in Streams," which appeared in the *Publications in Geography* of the University of California, Vol. 6 (1932), No. 1. In this article he states: "There can be no doubt that the energy of acceleration is transmitted by turbulence in the direction of decreasing velocity." Thus materials moving in flowing water must be drawn to the regions of low velocity. As is clearly shown in Fig. 1, that is exactly what happens to the oat grains.

The fact that surface floats are drawn to the regions of high velocities will offer no contradiction to this principle when it is considered that floats are simply riding on the water, and are not subject to the water pressure on all sides. Floats, which are acted on by different forces, would be expected to behave differently from completely submerged particles.

It is evident that water is not a perfect fluid, and that, since it has mass, it will tend to flow in a straight line when once started along a path. When it comes to a bend, its natural tendency therefore is to flow straight across to the concave bank, where it is deflected and turned. In turning from its course a certain superelevation is induced by reason of centrifugal force, which must be balanced.

Observations reveal that shallow depths are produced along the convex bank, resulting in a general lowering of velocities in that vicinity. This action, combined with an eddy below the point, tends to form deposits on the convex side. The effect of greater slopes along this side is generally overcome in normal river bends by the tendencies just described, but where the bend is very sharp it frequently happens that the difference in slope along the convex and concave banks is sufficient to overcome these tendencies, and in this case bars are formed on the concave side while steep banks develop on the convex side. These phenomena, actually found at several points in the Mississippi, tend further to discredit the theory of helicoidal flow and lend credence to the belief that movement of bed materials is by turbulence in the direction of decreasing velocities.

The purpose of this article is not to attack the theory of helicoidal flow and to put a new theory in its place. The data of Fig. 1 are simply advanced as indicating that perhaps helicoidal flow has been accepted without conclusive proof of its existence, and that the conception of Professor Leighly may be nearer to the real truth than any other explanation yet offered for the apparently contradictory movement of bed currents and bed materials. Certain it is that materials cross the stream course at a bend to build a bar, but if there is no definite flow of water in the same direction, helicoidal flow becomes a mere myth in spite of all theoretical considerations and assumptions to the contrary.

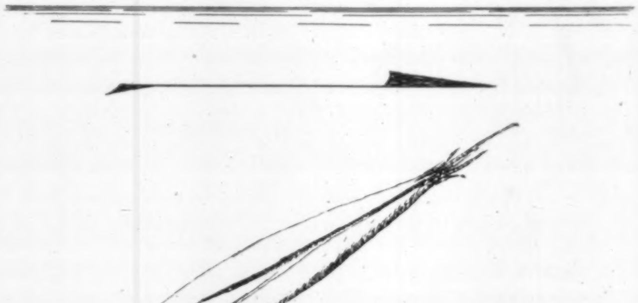


FIG. 2. POSITION OF AN OAT GRAIN ON THE STREAM BED

Have Pedestrians Legal Rights?

Court Decisions in the United States of Interest to Traffic Engineers

By ARTHUR H. BLANCHARD
MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
HIGHWAY TRAFFIC CONTROL AND TRANSPORT CONSULTANT, PROVIDENCE, R.I.

FOR years the American public has stood aghast at the fearful mortality on its highways. Engineers particularly have taken the matter to heart, but their efforts in providing increased safety in road design have been largely offset by the motorist's simple expedient of increasing his speed. Meanwhile the pedestrian has not been without his advocates in the courts, as here shown. This article has been abstracted from the address delivered by Mr. Blanchard at the annual meeting of the Institute of Traffic Engineers in Washington, D.C., on October 6, 1932. The complete paper, including an extensive bibliography, is available for study in the Engineering Societies Library at the Society's headquarters in New York.

LONG ago Cicero stated that "laws were devised for the safety of citizens and the preservation of states." Under this definition the law should provide adequate protection for the pedestrian.

More and more the query arises as to the responsibility for pedestrian accidents. In *Tremendous Trifles*, a publication (1932) of the Travelers Insurance Company, the general statement is made that "645,000 of the 860,000 accidents which occurred [in 1931] involved some improper action by drivers." Rhode Island statistics indicate that in the five-year period, 1927 to 1931, the percentage of accidents due to faults of motorists increased from 66 to 90 per cent, while the percentage due to faults of pedestrians decreased from 30 to 8 per cent. A dead pedestrian may not obtain much satisfaction from these statistics, but the pedestrians still numbered among the living in Rhode Island have the gratification of knowing that, in the past five years, they have greatly increased their efficiency in coping with traffic hazards.

If they would only peruse some of the court decisions involving contributory negligence on the part of motorists, many uncivil, haughty vehicular operators might modify their driving practice and in the future no more, by their actions, shout, with the spirit of Julius Caesar, "I came, I saw, I conquered" the hapless pedestrian.

A dissertation on a legal subject is enhanced in value by the inclusion of the fundamentals of the relevant court and judicial procedure. In practically all serious pedestrian accidents, the pedestrian or his kin takes advantage of the universal right of every citizen to be tried before a jury. As a result of court jurisdiction or appeal to a higher court, pedestrian accident cases are tried in a great variety of state and Federal courts. From the standpoint of law, pedestrian accident cases are usually decided on the basis of English common law, statutory laws, judicial interpretation of laws, or a combination of these. In his book, *Business Law* (1920), Thomas Conyngton concisely and clearly describes the status of laws in the United States as follows: "Our system of laws is an inheritance from our Anglo-Saxon ancestors, supplemented by written constitutions and multitudinous legislative enactments. Much of our law is judge-made. Like our forebears, we revere precedents and decisions and have more of this kind of law than we know how to use." He further states that "the common law gives way whenever it comes in conflict with statute law."

In the United States no legislation has been enacted by Congress which is applicable to pedestrian accident cases, although England has had national statutory laws relative to highway traffic for many decades, the latest being the 1930 Road Traffic Act. It seems highly desirable that our American traffic specialists should give profound consideration to the far-reaching provisions of this act and the advisability of the enactment of a similar law by the Congress of the United States.

A brief statement pertaining to the validity of municipal ordinances, as reflected in the following court decision, is pertinent: "When the general law of the state has dealt comprehensively with the subject matter of a municipal ordinance, the general law is dominant and controlling, and the ordinance is invalid and unenforceable, in the absence of specific authority therefor, conferred by the Legislature." State v. Robinson, 104 S.E. 473.

Particular attention should be given to what is commonly designated in court procedure as contributory negligence. Proved acts, resulting in accidents caused either by the motorist or the pedestrian, which are in violation of English common law or statutory laws and regulations, generally constitute contributory negligence. However, there are innumerable instances where decisions based on contributory negligence do not fall within this category.

A deciding factor in some cases is what is called "last clear chance," as, for instance, a court ruled in West Virginia that: "Where automobilist, in exercise of proper care, could have seen pedestrian negligently attempting to cross highway from behind bus after alighting therefrom, last clear chance doctrine was applicable, rendering automobilist liable, notwithstanding pedestrian's contributory negligence." Smith v. Gould (W.Va.), 159 S.E. 53.

From this brief picture, it can be readily seen that the instructions on points of law by the judiciary to juries may justifiably differ to a wide degree in the multiplicity of courts throughout the United States. Deductions relative to legal citations must perforce be made with these conditions constantly in mind.

From the viewpoint of the traffic engineer, per se, the judicial pronouncement or a jury verdict relative to a pedestrian accident case probably is of maximum interest as it effects possible modification of traffic-control practice. The few citations of cases that will be here presented briefly will each be followed by an illustrative deduction pertaining to a possible modification of traffic engineering practice in some states or municipalities.

SIGNAL CONTROL FOR PEDESTRIANS

First there is the District of Columbia case in which pedestrians started to cross on a "go" signal and continued to cross on a "stop" signal. "At controlled intersections, pedestrians have the right of way along with other traffic moving in observance with traffic signals. The plaintiffs entered the crossing while the green signal light was displayed, and having committed themselves to the crossing," the court decided, "they had the right of way until they could reach the opposite curb." Griffith v. Slaybaugh, 58 App. D.C. 237.

Courtesy National Safety Council

PEDESTRIAN HAZARD AT A STREET CAR STOP

Many Cities Require Automobile Traffic to Stop Behind Stationary Street Cars

Although traffic control signal practice has developed rapidly during the past few years, it is found, in retrospect, that the pedestrian has been given scant consideration. However, the sun is breaking through for the pedestrian. Both Philadelphia and Pittsburgh are using "pedestrian clearance intervals," designed to give a predetermined period of leeway at the end of the crossing interval, so that any pedestrian who has already started may have a reasonable time in which to reach the other side before counter traffic interferes. These periods are marked by an amber light so that a combination of green and amber shows during the pedestrian clearance interval. From the standpoint of justice to the pedestrian and because of its self-evident advantages, the general adoption of this clearance interval is strongly advocated.

PROVISION FOR UNCONTROLLED INTERSECTIONS

The next citation is from Pennsylvania and relates to a pedestrian crossing at an uncontrolled intersection. The decision affirmed that: "Where a pedestrian without negligence on his part has committed himself to the crossing, he has the superior right of way as against a vehicle thereafter approaching." Twinn v. Noble, 270 Pa. 500.

For example, this ruling would apply at intersections where there is not sufficient motor-vehicle traffic on both streets to warrant the installation of the usual type of signal but where many pedestrians have to cross a heavy flow of vehicular traffic, for which situation a pedestrian-actuated signal may be used. This permits a pedestrian to stop vehicular traffic, when he wishes to cross the roadway, by pressing a button, thus for a brief interval bringing into action the red light against vehicular traffic. In view of the justifiable and legal rights of pedestrians and because of the current attitude of the average motorist toward the pedestrian who endeavors to cross at an uncontrolled intersection, it is evident that signals of this type should be installed at many locations in both urban and rural districts.

Another instance from Pennsylvania has to do with a pedestrian crossing a roadway between intersections. The judicial decision speaks for itself: "The Pennsylvania court holds that a pedestrian starting to cross the street has no duty to stop, but he must look and listen to ascertain if vehicles are coming. He must further be on his guard after he starts across the street and must continue on the alert while crossing the entire roadway." Lorah v. Rinehart, 243 Pa. St. 231.

An Illinois case was brought by a pedestrian who entered the roadway from behind a parked vehicle. Said the court, "A pedestrian who goes between two vehicles and emerges in the line of traffic where his presence could not be seen or anticipated is negligent." Hooper v. Adams Express Company, Ill. 124 N.E. 445.

How should we deal with problems relative to the pedestrian, as illustrated by the two cases just cited? The answer is by practical statutory regulation of pedestrian traffic and its enforcement.

Courtesy National Safety Council

CONTRIBUTORY NEGLIGENCE?

Pedestrians "Must Continue on the Alert While Crossing the Entire Roadway"

In the State of Washington a judgment was sought relative to a pedestrian passing in front of a street car. The suit established the principle that: "One alighting from a street car and walking rapidly across in front of it is not necessarily careless in not looking to the left, as she is not bound to anticipate a vehicle coming up on the left side of the street." Mickelson v. Fisher, 81 Wash. 423.

Some municipalities allow, under their traffic ordinances, a motorist to pass a street car, either in motion or standing, on the left. In the interests of safety to pedestrians, it appears that driving past a standing street car on the left should be prohibited.

PEDESTRIANS ON RURAL HIGHWAYS

Another Pennsylvania case refers to a pedestrian on the roadway of a rural highway without a sidewalk. The court affirmed that: "Where there is no sidewalk, pedestrians' rights upon the paved roadway are equal to those of vehicles." King v. Brillhart, 271 Pa. St. 301.

Attention should be called to the just claims of pedestrians—and the more enlightened motorists—that sidewalks should be constructed on sections of rural highways where there is considerable pedestrian traffic on the roadway. The question may well be asked: Do pedestrian accidents happen on rural highways? It has been estimated that, while walking on, or along, rural highways throughout the United States, 2,330 persons were killed and 11,800 were injured by motorists during 1931.

What is the status of rural sidewalk legislation today? The 1931 Report of the American Society of Municipal

Engineers' Committee on *Highway Sidewalks* states that "practically every state of the United States had enacted laws, whether by design or oversight, which do not authorize state expense for walkways on state roads. . . . Only New York, New Jersey, and Massachusetts have passed enabling acts as to state highway sidewalks."

Courtesy Automatic Signal Corporation

Intersection Completely Controlled by Automatic Traffic Signals
Including Pedestrian Actuated Signal to Stop Vehicles

It is very gratifying to be able to record recognition in Great Britain of the vital necessity of enabling legislation, as indicated by the following excerpt from the Road Traffic Act of 1930: "It is hereby declared to be the duty of a highway authority to provide wherever they shall deem it necessary or desirable for the safety or accommodation of foot passengers, proper and sufficient footpaths by the side of roads under their control."

In Connecticut action was brought relative to a pedestrian accident due to a motor vehicle being operated without proper lights. The ruling of the court was to the effect that: "A regulation relative to lights may be deemed to be for the protection of pedestrians as well as for vehicles, so that a pedestrian injured by an automobile may ground his action on the failure of the driver to have the machine properly equipped with lights." Carbone v. Krott, 100 Conn. 414.

Many cases of this character emphasize the necessity, in the interests of safety and the reduction of accidents, of modifying some state motor-vehicle laws in order to prohibit the use on motor vehicles in motion of lights that will not render clearly discernible persons or objects at least 200 ft in front.

Courtesy Automatic Signal Corporation

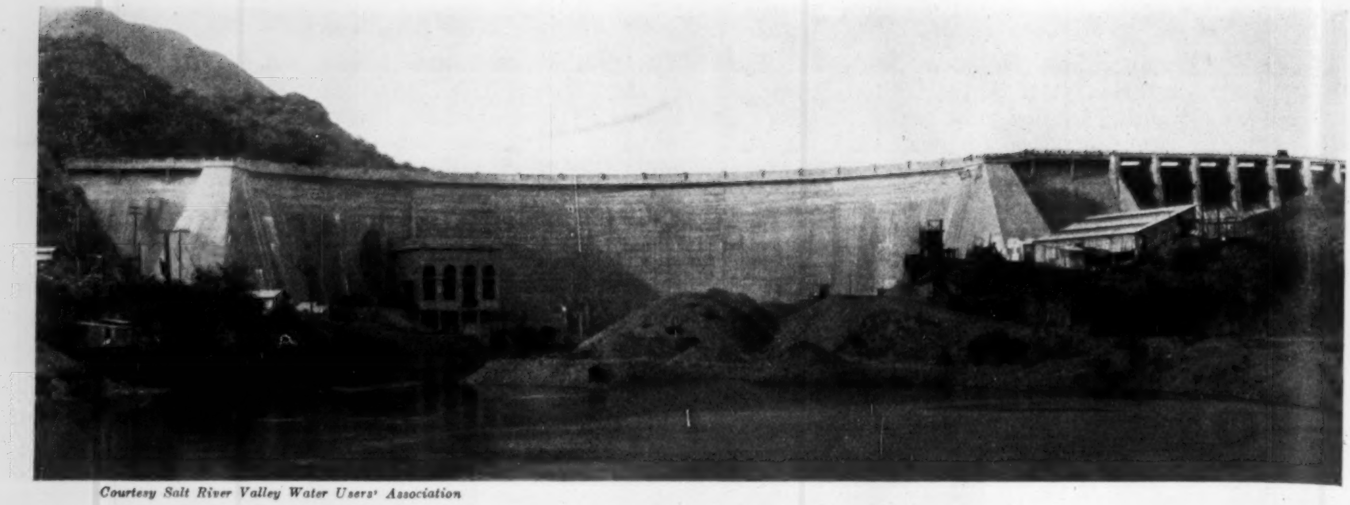
Pedestrian Actuated Signal
Halts Vehicular Traffic for a Brief Period

Proper protection for pedestrians is one of the outstanding responsibilities of the present-day traffic engineer. First and foremost is the imperative modification of traffic control practice wherever provision is lacking for clearance of pedestrians legally on a crosswalk at a controlled intersection. Success of the systems in Philadelphia and Pittsburgh points to one solution of this difficulty.

Determination of what constitutes "reasonable or proper" speed, especially in connection with varying local conditions, is another thorny problem. In practically all states and municipalities where a speed limitation of this character is contained in statutory laws and ordinances, respectively, the decision has been left entirely to the individual operator. His status has been appropriately stated thus: "Your individualist may be a valuable citizen, but he's a dangerous nuisance behind a steering wheel." The practice in Rhode Island, where "reasonable or proper" speeds for different locations have been determined by specialists, is favored. On the state highways of that commonwealth signs have been erected indicating "reasonable or proper" speeds varying from 20 to 45 miles per hr for different sections of a given route.

Closely related to the "reasonable or proper" speed problem is that of the determination by traffic engineers, of logical and practical interpretations of the phrases, "under control" and "slow down," as applied to a motor vehicle just approaching an intersection. An analysis of pedestrian accident cases will furnish many illustrations of the importance of the solution of these problems, as they constitute the crux of many such lawsuits.

The examples cited represent only a few of those forming the basis of traffic accident cases involving pedestrians, as anyone may see who investigates the wealth of citations contained in the standard treatises on automobile law. It is well to ask ourselves whether conditions today do not warrant the conclusions of the late William McAdoo, one-time Police Commissioner and later Chief City Magistrate of New York, expressed before traffic regulations were first adopted in that city in 1903. He affirmed that: "The jostle and struggle between the driver and pedestrian had been for many, many years a fixed condition, quietly accepted by the multitudes. The driver, on his part, believed that the street belonged exclusively to him and . . . he sat on his throne as one beyond the law. The citizens went daily, with more or less courage, through greater perils and dangers than an arctic explorer . . . or a hunter of dangerous wild beasts would encounter, glad at times to gain the curb, frequently escaping a violent and cruel death by a hair's breadth."



Courtesy Salt River Valley Water Users' Association

STEWART MOUNTAIN DAM ON THE SALT RIVER, NEAR MESA, ARIZ.
An Arched Power Structure of the Salt River Irrigation Project

Arizona Adopts a Code for Dams—Part II

A Résumé of the Regulations Adopted by the State Engineer for Their Design and Construction

By J. A. FRAPS
ASSOCIATE MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
ENGINEER, STATE ENGINEER'S OFFICE, PHOENIX, ARIZ.

IN the April issue, Mr. Fraps took up that part of Arizona's Code on Dams which deals with such items as foundations, spillways and outlet works, and the construction of earth dams. In the second and last part of his résumé he considers rock-fill, gravity, vertical-arch, and multiple-arch types, together with desirable concrete mixes and methods of placing them. The importance of imposing state supervision in the design and construction of dams has been emphasized by the great loss of life and property that has resulted from the failure of such structures. In the interest not only of improving the code itself but also of ensuring the uniform stability and safety of dams, it is hoped that this résumé of Arizona's code will be generously discussed by engineers. A copy of the complete code is on file in the Engineering Societies Library in New York.

FOR dams of great height, the rock-fill type is looked upon favorably in Arizona's official Code on Dams, provided fundamentals of design and construction are not violated. Good foundations are essential, and great importance is attached to an impervious upstream facing.

A minimum crest width of 12 ft should be used in structures less than 50 ft in height. Rock-fill dams of 50 and 100 ft in height must have minimum crest widths of 12 and 16 ft, respectively, with proportionate widths for intermediate heights. A minimum crest width of 16 ft is required for dams in excess of 100 ft in height. The downstream slope must never be steeper than the natural angle of repose of the material in the fill, nor may it be steeper than 1.4 to 1. When a thin layer of derrick-placed rock is used on the upstream face, no slope steeper than 1.3 to 1 is permitted. If a great thickness of derrick-placed rock is included in the design, a steeper slope may be used. A sliding factor of 0.30 must not be exceeded.

A thin layer of derrick-placed rock on the upstream face is not considered as adding greatly to the stability of a rock-fill dam. Its chief function is to furnish a surface on which to place the impervious facing. Minimum thicknesses of derrick-placed rock are not established in the code.

An impervious upstream facing composed of a single reinforced concrete slab is not considered as good as the flexible, laminated facing recently devised. In either case, it is essential to secure a flexible joint at the junction of the slab with the concrete cut-off wall in the stream bed and at the abutments. Minimum requirements for the thickness of upstream facings are not given in the code.

No lower limit is prescribed for the size of the rock in the fill, but an excess of fines that would prevent the fill from being self-draining, or would increase settlement, should be avoided. There is no upper limit as to size of rock. Any rock used in the fill must be resistant to weathering and hard enough to resist crushing or spalling under the combined weight of fill and water load. The State Engineer's Office does not look on the practice of building rock-fill dams in high vertical lifts as satisfactory. It is stated that successive lifts are to be not more than 20 ft apart vertically, and less if necessary in the case of special materials.

A rock-fill dam is subject to the same restrictions regarding flood control during construction as an earth-fill dam.

GRAVITY DAMS, STRAIGHT AND CURVED

The discussion of gravity dams in the code is confined to the straight and curved types. Restrictions regarding one type are deemed applicable to the other, except for minor points, which are discussed separately.

If a positive system of drains is installed in a gravity dam, full hydrostatic uplift must be assumed as acting over the area between the upstream face of the dam and the vertical drains at bedrock. Uplift equal to the head produced by maximum backwater level must be assumed to act on the remainder of the dam. It is prescribed that there shall be a positive system of drains to satisfy the following five requirements:

1. There must be vertical drain holes close to the upstream face, from the crest of the dam to points below the surface of the foundation rock. These drains are to be constructed so that they can be periodically cleaned.
2. An open drainage gallery is to be constructed in the concrete, parallel with and close to the upstream face, extending entirely from end to end of the dam, as close as practicable to bedrock.
3. A tunnel is to be built parallel to the axis of the stream, from the gallery mentioned under the second requirement to the toe of the dam at the lowest elevation practicable.
4. The gallery mentioned under the second requirement will collect water from all vertical drain holes, both above and below the gallery. It will also permit the maintenance of bedrock drains by re-drilling or reaming the holes. The dimensions of the gallery will be governed by the requirements of inspection and drilling.
5. When inclined contraction joints are placed parallel to the lines of the first principal stress, adequate means must be taken to prevent hydrostatic pressures in these joints.

A design that includes an allowance for uplift is looked on as safer than one calling for the installation of a complete drainage system. When drains are omitted, uplift must be assumed to vary from 75 per cent of the full hydrostatic pressure at the heel, or upstream face, to tailwater head at the toe. A more liberal allowance for uplift may be required in the event that foundation conditions are not good. Uplift must also be assumed to act at every horizontal joint.

The State Engineer's Office does not consider the sliding factor an index to the safety of a gravity dam. Great stress will be laid on proper foundation materials, preparation of foundations, including stepping, and placing of foundation concrete. If proper precautions are taken with the foundation, it is believed that complete shear across any horizontal section of the dam proper, or between the concrete and the rock, must occur before there will be any sliding. A much greater force is demanded to produce failure through shear when foundation conditions are proper, than is required to exceed the higher figures adopted for sliding factors.

It is prescribed that ice pressure be considered in the design of any gravity dam situated at the higher elevations in the state. A definite value for ice pressure has not been adopted, since the character of the reservoir and the slope of the upstream face of the dam will be different in different structures. When spillway gates are used, the ice pressure is to be applied at the elevation of the water surface when the gates are at their highest elevation. If they are not used, the elevation of the spillway crest will govern.

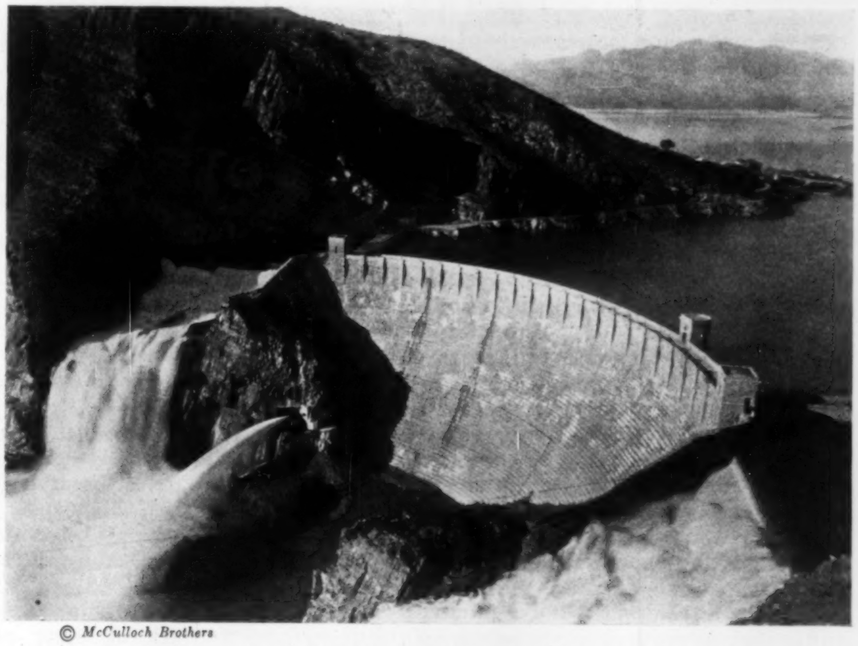
An allowance must be made for silt pressure against the upstream face of a gravity dam. The horizontal pressure of a saturated silt load must be included.

A drop in temperature in a large concrete dam is seen as an element of danger. Since steel reinforcing is uneconomical and impracticable, contraction joints or artificial cooling followed by grouting will be required. Contraction joints must be constructed in vertical planes parallel to the axis of the stream for straight gravity dams, or in radial planes for curved gravity dams. A spacing of 50 ft must not be exceeded. Keys are to be built into the faces of the joints to ensure monolithic action. Radial joints are to be grouted after the heat of setting has been dissipated. Contraction joints along planes parallel to the first principal stress are also considered desirable. A joint along this plane has the objection, however, that if carried to its logical intersection with the water face, it introduces hydrostatic pressures in the body of the dam. Suitable drains must be provided to prevent dangerous interior pressures along inclined contraction joints. These joints also destroy shearing resistance when the dam is considered elastically as a vertical cantilever. Provisions should therefore be made for positive interlocking of the joint surfaces.

CURVED GRAVITY DAMS REQUIRE CAREFUL DESIGN

When a gravity dam exceeds 150 ft in height, both first and second principal stresses are to be computed. The familiar formula, $S = \frac{P}{A} \pm \frac{Mc}{I}$, may be used for dams less than 150 ft high. A straight gravity type must be analyzed by taking a vertical slice 1 ft thick at the highest section, and the same vertical slice must be used for curved gravity dams, provided adequate pressure grouting is completed on all radial joints after a reasonable time has been allowed for the dissipation of the heat due to setting. It is prescribed that foundation deflections shall receive some study, although the exact amount of detailed investigation to be given this feature is not fixed. When contraction joints are placed parallel to the direction of the first principal stress, the individual inclined columns must be investigated.

The greatest objection to the curved gravity dam as usually constructed is that the foundations on the abutments slope downward from heel to toe along radial lines. This dangerous feature will be avoided by enforcing the rule that foundations be horizontal on radial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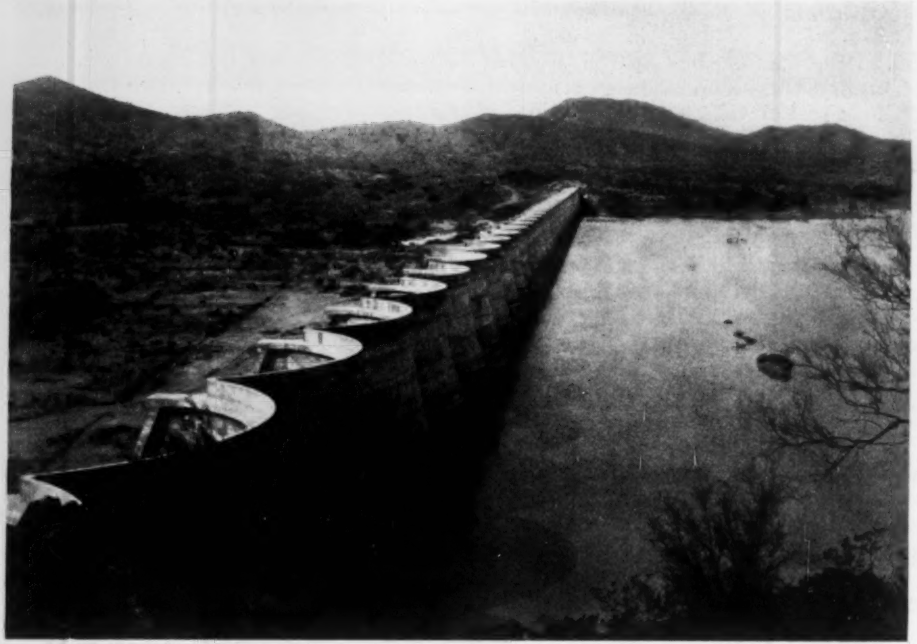
Roosevelt Dam, Salt River Irrigation Project, Arizona

Curved Gravity Structure Passing 1920 Flood; Spillway Gates Were Installed in 1927 lines. Contraction joints often become open joints after cooling, thus preventing arch action. The code prescribes that all radial contraction joints must be grouted, a procedure which should correct this fault.

When an excellent rock is available at the dam site, a gravity dam may be overtopped during construction. Care must be taken to prevent scour at the toe.



Courtesy Vic H. Householder

CAVE CREEK FLOOD CONTROL DAM, NEAR PHOENIX, ARIZ.
Multiple-Arch Type Built in 1923

VERTICAL ARCH DAMS FAVORED

Single-arch dams are considered an excellent type, since the structural failure of such a dam has not been recorded. Careful supervision is considered necessary, however, because designers are continually using thinner sections and higher stresses. An exact analysis of a single-arch dam has not yet been devised. This fact is recognized by the code, which lists the generally acceptable methods of design.

Uplift is not considered as a necessary factor in the design of a vertical-arch dam. Temperature has a very definite effect on the arch rings, and is to be considered. The heat of setting of the concrete must be dissipated by proper construction methods, or else the design will have to allow for a great temperature variation. The maximum variation for thin arch dams, where the heat of setting has been dissipated, is ±40 F. This is at the top of the dam; smaller amounts may be taken at lower elevations. A change of ±10 F will be the minimum at stream-bed elevation or above, and no temperature variation need be assumed for arch rings that are more than 25 ft below the stream bed. Rib shortening effects must be included in all arch designs. Ice and silt pressures must also be considered.

In the determination of stresses, the dam may be considered as a series of horizontal arch rings fixed at the abutments and free to slide on each other. Stresses are to be computed by the application of the elastic theory. The cylinder formula is not deemed adequate. The water load may be divided between horizontal arch rings and vertical cantilevers in a proportion that will result in equal deflections of the arch and cantilever at any point in question. The practice of utilizing what is generally termed the "secondary arch" does not meet with the approval of the State Engineer's Office. The arch found suitable for any particular elevation must be used there. If this introduces upward water pressures they are to be compensated by a vertical water load on the upper part of the dam. In other words, an upward water load is considered less objectionable than a primary arch that must crack to permit the secondary arch to act.

Studies have been made by the U.S. Bureau of Reclamation regarding the effect on arch dams of twisting moments in horizontal and vertical sections; of tangential shearing forces in horizontal sections and corresponding vertical shearing stresses in radial sections; and of Poisson's ratio. These refinements will not be required at present, but they may be included if desired by the designers of arch dams. Results of telemeter measurements of internal stresses in large arch dams are expected to be of material benefit in the future.

Unless contraction joints are used, a drop of 40 F must be allowed for the design to take care of the stresses induced by the loss of the heat of setting. This allowance, which will be in addition to that made for atmospheric variations, virtually requires the use of radial contraction joints. One of several different methods may be adopted to provide contraction joints. It will be necessary to grout between the joints after the heat of setting has been dissipated.

A concrete arch dam may be overtopped during construction without danger, provided the foundation rock is of good quality. In such a case it will be necessary for the owner to take ample precautions to prevent damage from scour at the toe of the dam.

MULTIPLE-ARCH DAMS PROVE SUCCESSFUL

Most dams of the multiple-arch type have been very successful, but some of the higher ones have been a source of concern, principally because of cracks in the buttresses. It is considered that this defect can be remedied by proper foundation treatment and conservative design. It seems to demonstrate, however, that caution must be used when height is great. The code is deemed applicable for multiple-arch dams not over 250 ft high. This does not mean that higher dams of this type will not be considered, but rather that their design must be more conservative than that required by the code.

No consideration need be given to uplift in multiple-arch dams of the dimensions generally employed. If the spacing of buttresses is increased greatly, some consideration must necessarily be given to uplift. In any event, its effect will be small compared with that in a gravity dam of equal height. A sliding factor has not been adopted for multiple-arch dams, since the requirement for good foundations is considered of more importance. The same reason applies as in the case of gravity dams. The tendency of a structure to slide is to be overcome, not by a great weight above foundation level, but rather by firmly embedding good concrete in suitable rock. The requirements for silt and ice pressure are the same for multiple-arch as for gravity and vertical-arch structures. The sloping upstream face of the multiple-arch type will materially reduce the ice pressure against the dam.

In designing buttresses, it is required that vertical stresses on horizontal sections be obtained, and in addition that shears, trajectories, and intensities of first and second principal stresses be computed. Principal stresses will not be required for buttresses less than 75 ft high. When contraction joints are used, the individual inclined columns are to be investigated for stability. Care must be exercised not to design a buttress that has a high slenderness ratio. The H-type buttress is believed to be a good design to prevent buckling, provided a proper system of cross walls and struts is used. External lateral bracing with struts is not considered as effective as the H-type buttress. Steel reinforcement is usually placed in the buttresses of multiple-arch dams.

It will generally be uneconomical to reinforce against temperature in buttresses over 100 ft high. Contraction joints along the trajectories of the first principal stress are considered more economical and fully satisfactory. A maximum horizontal spacing of 50 ft is specified, except at the heel of the dam, where 100 ft is permissible. It is specified that contraction joints shall not extend to the upstream face of a buttress, and that heavy steel reinforcement shall be placed between the upper end of the joint and the water face. Horizontal steel must not continue through contraction joints. The water slab used on the H-type buttress to carry the load between the two buttress walls should be designed as a beam fixed at both ends.

DESIGN OF ARCHES CONSIDERED

An arch is to be designed by taking a 1-ft slice of the barrel in a plane normal to the springing line, or in the plane of the stiffest arch. The cylinder formula is not deemed applicable. Any method based on the elastic theory will be accepted. The analysis is to include a determination of stresses when the water is at the elevation of the crown of the arch, and also when it is at maximum elevation. A temperature variation of ±40 F must be used for the uppermost arches, decreasing uniformly to ±15 F at the arch 25 ft below the stream bed. These requirements will apply to the usual multiple-arch type, but not to very thin or unusually thick arches. Rib shortening due to load and temperature is to be included in the analysis. There must be no tension in the arches due to maximum water loads. Tension is bound to result from temperature and rib shortening, which must be provided for in full by steel reinforcing.

A multiple-arch dam should not be overtopped to any great extent during construction. The use of thin sections and buttresses incapable of assuming lateral pressures will demand that water be by-passed instead of allowed to go over the top of the dam. Care must be taken also to prevent scour of foundation rock and undercutting of buttress footings.

Courtesy Salt River Valley Water Users' Association

Horse Mesa Power Dam on the Salt River, Nearing Completion (1927)
The Arizona Code, Adopted in October 1932, Does Not Advocate Chutes for Placing Concrete

The code prescribes several factors that are used frequently in design calculations. A modulus of elasticity of 2,750,000 lb per sq in. is deemed applicable for concrete when high stresses occur. Designs will be accepted that are based on a factor of 0.000,005 per deg F for the coefficient of linear expansion. Concrete must be assumed to have an average weight of not more than 145 lb per cu ft, unless tests of the materials that are to be used in the structure justify a different assumption.

SPECIFIED QUALITIES OF CONCRETE

The code urges the use of only good concrete mixes for hydraulic structures. Not only should concrete meet the specified strengths, but it should have qualities of high weather resistance and imperviousness, and a low shrinkage coefficient. The ingredients going into a mix must be proportioned by making a suitable number of laboratory tests. Frequent field tests during construction are necessary to accommodate the mix to the changes that are bound to occur. Mixing and placing processes are to be designed to produce a concrete having the desirable qualities mentioned for hydraulic structures. Proper curing methods are considered to have at least as much value as an additional sack of cement per cubic yard of concrete. The desired degree of impermeability can be secured by properly proportioning the mix, by using good aggregates, and by keeping the water content low. It is not believed possible to obtain a low shrinkage coefficient when finely ground and quick-setting cements are used. On the other hand, if the chemical heat of setting can be kept low, there will be a reduction in the shrinkage of the concrete. Artificial means for dissipating the heat of setting can be used in some structures.

The crushing strength of the foundation rock must be a safe percentage of the maximum compressive stress in the concrete. If the rock is of suitable quality, the maximum allowable unit compressive stress in the concrete will be limited to 25 per cent of the ultimate unit crushing strength at 28 days, as determined by tests of standard 6 by 12-in. concrete cylinders. An upper limit of 650 lb per sq in. for the working stress shall not be exceeded. In gravity dams and buttresses, the maximum stress is to be considered the greatest first principal stress, and in arches it is to be considered the greatest stress resulting from all exterior forces, from temperature, and from rib shortening. It is further specified that a maximum of 1.5 bbl of cement per cu yd of concrete be not exceeded, because a greater quantity would indicate either poor cement or poor aggregates. A minimum compressive strength of 2,200 lb per sq in. at 28 days is specified for hydraulic structures on account of the necessity for imperviousness and durability.

Concrete must not be given a working value in tension. The tensile stress must not exceed 100 lb per sq in., which is to be provided for in full by steel reinforcing. The following maximum stresses are also specified for shear or diagonal tension:

Beams without shear reinforcement:	
Longitudinal bars not anchored	40 lb per sq in.
Longitudinal bars anchored	80 lb per sq in.
Beams with shear reinforcement, and anchorage	120 lb per sq in.

A value of 120 lb per sq in. may be used in punching shear. Reinforcing steel may be stressed to 16,000 lb per sq in. in tension, and in compression to an amount 10 times the compression in the surrounding concrete. A bond stress of 80 lb per sq in. is permitted between the concrete and unanchored bars. Bars adequately anchored may have a bond stress not exceeding 120 lb per sq in.

It is prescribed that the structural steel used in hydraulic structures shall conform to the standard specifications adopted by the American Society for Testing Materials, as listed under their serial designations A7-29 and A9-29, and all subsequent revisions thereto. Limiting stresses in structural steel must conform to the requirements of the standard specifications adopted by the American Institute of Steel Construction, as found in the first edition of *Steel Construction*.

Where bridges or similar structures are built of structural steel, as appurtenances to dams, limiting stresses must conform to the requirements of the U.S. Department of Agriculture, Bulletin No. 1259.

LABORATORY TESTS REQUIRED TO DETERMINE MIX

General specifications for concrete materials and for mixing, placing, and curing, are also discussed in the code. Specifications for water, cement, sand, coarse aggregate, cobble rock, reinforcing steel, structural shapes, and steel-wire reinforcement are all listed. Many standard specifications are referred to, particularly those of the American Society for Testing Materials. Admixtures are not recommended for the concrete that goes into a dam, but will be permitted if the owner can show actual improvement from laboratory tests. Two concrete mixes are specified, as shown in Table III.

TABLE III. CONCRETE MIXES AND PERMISSIBLE STRENGTHS

CLASS	NOMINAL PROPORTIONS	APPROXIMATE CEMENT CONSUMPTION Lb per Cu Yd	WATER-CEMENT RATIO	AVERAGE SLUMP Inches	COMPRESSIVE STRENGTH AT 28 DAYS Lb per Sq In.
A . .	1 : 2 : 3.5	586	0.83 (6.25 gal per sack)	3 to 4	3,000
B . .	1 : 2.5 : 3.5	529	1.00 (7.5 gal per sack)	3 to 4	2,200

These mixes are based on the averages of typical aggregates that have been used in Arizona, but should not be adopted except as a general indication of probable strengths. It is specifically required that laboratory tests shall be made before the final mix for the concrete in a dam is adopted. These tests are to be made with typical samples of cement, sand, and coarse aggregates.

Stress is laid on the necessity for preparing foundations and construction joints in a proper manner. A layer of grout must be placed on the foundations and on old concrete surfaces before the regular mix is placed. Forms and falsework must be built to prevent excessive movement during the placing of the concrete. The use of steel wires or rods extending from one face of the dam to the other is not approved for hydraulic structures. Reinforcing steel is to be placed at least 4 in. from the water surface of the dam.

CONTROL OF MATERIALS, AND METHODS OF PLACING AND CURING

Control must be exercised over the quantities of water, cement, sand, and coarse aggregate that go into a mix. Weighing is considered better than measuring, although the latter will be permitted. The volume or weight of the sand must be compensated for moisture content. Concrete is not to be placed when the temperature of the air exceeds 115 F, or is less than 40 F.

Chutes are not recommended for transporting the concrete that goes into a dam. It is believed that a greater water-cement ratio is usually required to permit the economical use of chutes than would be otherwise desirable. It is not considered desirable to drop concrete more than 5 ft vertically, a distance that is materially exceeded when "elephant trunks" are used with chutes. Great care must be taken in tamping or rodding concrete, to be sure that it makes contact with old concrete surfaces and completely covers all steel reinforcement. The rate of placing concrete should be as slow as is demanded for the safety of the dam. The belief is expressed in the code that concrete is usually cured improperly. It is specified that all concrete surfaces shall be kept moist or wet for a period of not less than two weeks after placing, and preferably longer. When concrete is poured during cold weather, suitable means must be provided to keep it at a temperature of at least 50 F for 72 hr after placing. Test cylinders will be taken by the state inspector on the work throughout the construction period.

ACKNOWLEDGMENTS

I wish to acknowledge the valuable assistance of W. W. Lane, M. Am. Soc. C.E., former State Engineer of Arizona, under whose direction I prepared the original code. The revised code has been prepared under the direction of State Engineer T. S. O'Connell, M. Am. Soc. C.E., who has contributed liberally of his time and knowledge.

In making acknowledgments for this work, particular reference is made to Fred A. Noetzli, M. Am. Soc. C.E., who, it is believed, issued the first code on dams in this country, and who presented a valuable discussion of the State Engineer's original code. A lengthy and extremely helpful discussion was also received from A. J. Wiley, M. Am. Soc. C.E., a few months prior to his death. Contributions of value also came from Dean G. M. Butler, of the University of Arizona; from W. H. Holmes, Assoc. M. Am. Soc. C.E.; and from Paul Bauman, James B. Girand, and J. B. Lippincott, Members Am. Soc. C E. All data pertaining to concrete have been prepared in collaboration with Julian W. Powers, Assoc. M. Am. Soc. C.E., engineer in charge of the laboratory of the Arizona Highway Department.

Population Trends and the Growth of Cities

An Analysis of the Basic Sociological Factors Underlying Urban Development

By W. RUSSELL TYLOR
ASSISTANT PROFESSOR OF SOCIOLOGY, UNIVERSITY OF ILLINOIS, URBANA

PROBLEMS in connection with the planning of municipal improvements require reasonably accurate engineering estimates of the population growth of cities, either by normal increase, by migration from rural districts, or by annexations of suburban territory. According to the last census, over 56 per cent of the people of the United States are urbanites, that is, they live in cities of over 2,500 inhabitants. Certain sections of the country, particularly the States of New York, Massachusetts, and Connecticut, are more than 90 per cent urban. In this article Professor Tylor develops the reasons for expecting a stationary state of population for the United States in the near future, due to the falling birth rate in both urban and rural districts. In nine leading American cities the true rate of natural increase had become a minus quantity by 1928. Engineers may well ask, to what extent will annexations continue to increase urban populations?

FIRST and foremost, cities do not consist of paved streets and tall buildings, but of people—people living in close proximity to one another in a relatively small though clearly defined corporate area, and collectively behaving in certain characteristic ways. This fundamental nature of the city is revealingly reflected in the various definitions of the term. Whereas the city planner, the architect, and the engineer are most apt to conceive of the city in terms of its thoroughfares, skyscrapers, dwellings, parks, and public improvements, the actual definitions of the city, for the most part, make no reference to its material structure or equipment. Rather do size, density, and occupation of the population, together with the nature of its corporate privileges and government, seem the primary determining concepts.

Basic to the whole problem of urban growth and development is the quantitative trend of the population in its various essential phases. A number of special studies of the past few years have thrown much light on these specific trends, both for the population of nations in general and of urban centers in particular.

A study made by the writer ten years ago, and published in *The North American Review* for November 1923, on the "Increase of Contemporary Peoples," analyzed the, "crude" birth and death rates with the resulting rates of natural increase for all the peoples of the world for whom vital statistics were available, from the beginning of the last century to date. Crude rates are respectively defined as total births and total deaths per 1,000 living at all ages, excluding still births. The rate of natural increase is then expressed as the difference between the crude birth rate and the crude death rate, and signifies the number of individuals per 1,000 added to a population during the year in question, apart from the factor of migration. The crude rate of natural increase in most countries tended to lie between the limits of 7 and 15 per 1,000. A rate as low as 7 requires about a hundred years to double a population, whereas a rate of 15, if maintained, doubles it in less than 50 years. This study also showed that the immediate effect of the World War was only that of a temporary check on the norm of population rates of increase. Most countries returned to their previous rate levels within two or three years after the cessation of the War.

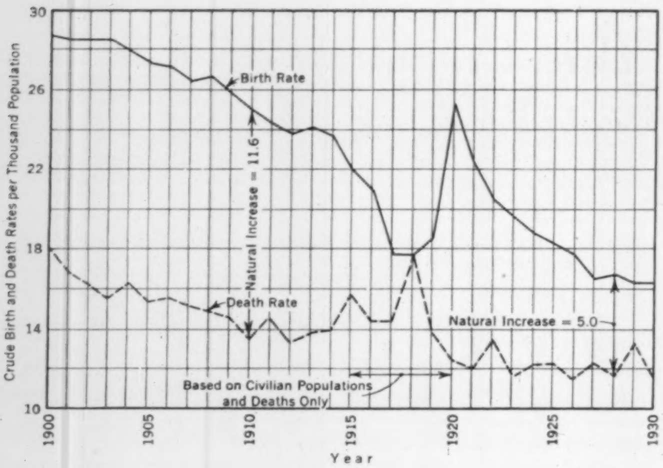
It is interesting to note that up to the last five years or so, authorities writing in the field—more particularly Professors Ross of Wisconsin, East of Harvard, Pearl of Johns Hopkins, and G. H. Knibbs, statistician for the Australian Commonwealth—have stressed the imminence and dangers of world overpopulation. More lately, however, and especially in the light of post-War data, newer studies are pointing if anything to the imminence and dangers of underpopulation. At best it is now apparent that the terms over- and underpopulation cannot be applied as blanket categories to the world's present 1,820 millions, but that the problems of the analysis of population trends consist in a more adequate interpretation of differential rates of increase.

VARYING RATES OF INCREASE

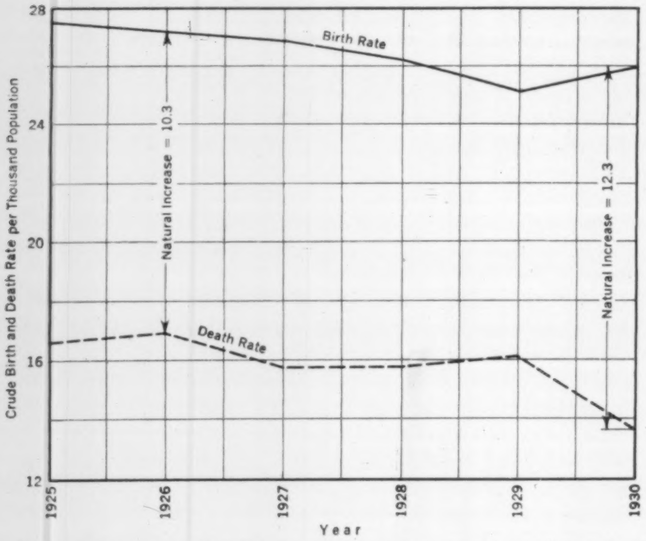
In dealing comprehensively with more recent world trends in the crude rates, Warren S. Thompson in "Population," appearing in the May 1929 issue of the *American Journal of Sociology*, divided the countries into three major groups. Group A, representing western Europe, America, and Australia, is characterized by a very rapidly declining birth and death rate, the birth rate declining more rapidly than the death rate, so that the rate of natural increase is also declining. Today the rate of natural increase in these countries is from 40 to 70 per cent less than it was immediately before and at the close of the World War. The curves shown in Fig. 1 (*a*), for England and Wales together, are typical of Class A countries.

Group B, consisting of Italy, Spain, and the Slavic peoples of Central Europe, is evidencing a decline in both the birth and death rates in certain classes, but the death rate is declining as rapidly if not more rapidly than the birth rate. As a result, in these countries the rate of natural increase will probably remain at its present level or even increase in the near future. This is shown graphically for Italy in Fig. 1 (*b*). A factor of prime importance in this connection is that these Group B countries are more rural today than the Group A countries were forty years ago, and rural peoples show a greater resistance to the spread of birth control than do city populations.

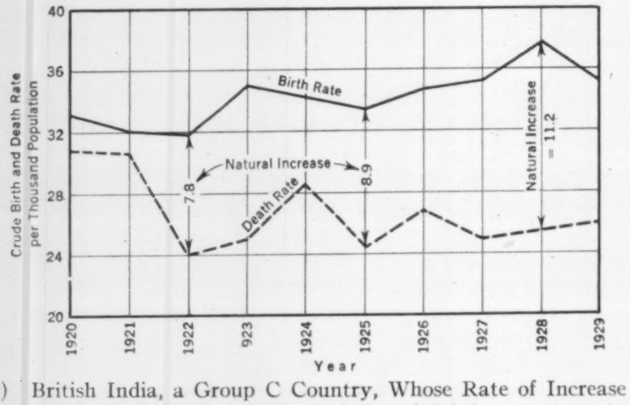
Group C includes Russia, Japan, India, and most of the peoples of Asia, Africa, and South America. Here both birth and death rates are less controlled than in countries of the A and B groups, and Malthus' "positive" checks to population growth—disease, famine, and war—are essentially operative. These Group C peoples constitute about three-quarters of the world's population, and with a lack of voluntary control over the vital rates, their growth in the near future will be determined largely by the opportunities they have to increase their means of subsistence. A study by B. Ganguli, published in the *Indian Journal of Economics* for January 1930, of 40 districts lying in the upper Ganges plain, specifically



(*a*) England and Wales, a Group A Country with a Falling Rate of Increase



(*b*) Italy, a Group B Country, with a Nearly Stationary Rate of Increase



(*c*) British India, a Group C Country, Whose Rate of Increase Is Dependent on the Availability of Subsistence

FIG. 1. CRUDE BIRTH- AND DEATH-RATE CURVES FOR TYPICAL COUNTRIES

With Resulting Rates of Natural Increase in Population

illustrates a pronounced tendency for the density of population to increase correspondingly with an increase in agricultural productivity. Curves for British India are shown in Fig. 1 (*c*).

According to an epidemiological report of the League of Nations, made in 1931, of 29 countries with comparable statistics, only five—Japan, Spain, Portugal, Ireland, and Russia—show a greater excess of births over deaths in 1928 and 1929 than they did in 1901 and 1905. Particularly is Japan's birth rate increasing, netting nearly a round million addition annually to Nippon's subjects. A comparison of the rates of natural increase in these countries is given in Fig. 2. While Japan is seeking to relieve the pressure in part by an imperial economic footing in Manchuria, it is to be noted that already some inward controls are emerging, as is indicated by the differentially slightly lower birth rate in the cities than in the rural districts of Japan. But then Japan was only 21.6 per cent urban in 1925—in reality more, on a basis comparable to Western countries—and yet in spite of urbanization her population for some time will undoubtedly expand as new means of subsistence are opened to it.

Estimates of China's rate of increase vary. A thorough though liberal study, as revealed in an article by Harry Paxton Howard in the June 20, 1929, issue of *China Critic* estimates the increase in China's half billion people—a population greater than that of Europe—as shown for the previous 19 years as sufficient to double her population in about 50 years. China is vastly rural, and the author feels that there is little likelihood of her population approaching a stationary state until more voluntary means of control are exercised.

POPULATION DENSITY AND AVAILABLE ARABLE LAND

The significance of these differential rates of increase among the peoples of the world is further indicated when they are examined in the light of the available land supply. A late study by O. E. Baker, senior agriculturist in the Bureau of Agricultural Economics, U.S. Department of Agriculture, Washington, D.C., published in the *Geographical Review* for July 1928, states that there is fully three times as much actual and potentially arable land per person in North America as in Europe and about six times as much as in southeastern Asia. In other words, where population rates of increase are greatest, the extent of arable land is least. The Group A peoples possess large areas of land which, as in Australia, they cannot settle and will not allow other peoples to settle. Over half the population of the globe, representing the countries whose rates of increase are expanding or due to expand in the immediate future, are confined to relatively restricted territories, in many cases almost destitute of mineral resources.

Russia alone constitutes an exception, for she is the one nation in the world today with an enormous rate of increase and expansive power who also possesses the territory to permit that expansion. Russia's vast territory constitutes one-seventh of the land surface of the earth and affords a relief from population pressure even though her 1927 rate of increase—20.4, the highest of late years recorded among any people—means the addition of 3,000,000 yearly to her numbers and is sufficient, if maintained, to double her population in 35 years, almost the proverbial Malthusian generation. Although applied to a population considerably larger than that of the United States, her rate of increase is far more than double that of America.

DECLINING BIRTH RATE IN THE UNITED STATES

In the United States the number of births reached the high mark of 2,950,000 in 1921. Since that year there has been an almost unbroken decline to 2,450,000 births, as indicated by preliminary figures for 1931. This latest figure is 500,000 lower than that of ten years ago, and represents a decline of nearly 17 per cent in the number of births, and a decline of more than 27 per cent in the crude birth rate. Although the excess of births over deaths was more than 11 times as important as net immigration in contributing to the population growth in 1930, this excess represented a 31 per cent decline from that of 1920.

A more accurate picture of the significance of these trends is revealed by an analysis of what Louis I. Dublin and Alfred J. Lotka, of the Metropolitan Life Insurance Company, have called "true rates" for births, deaths, and natural increase. These true rates are based on the stable age and sex composition that would result in any population group if the actual specific birth and death rates of this population at some given date were to remain in operation indefinitely, and if no migration were to occur. In the May 1930 issue of the *Publication of the American Sociological Society,* Dublin and Lotka point out in their analysis of true rates, that the birth rate cannot continue to fall indefinitely, and must sooner or later become stationary, or nearly so.

On the basis of such true rates, and assuming a low net immigration figure (for the first nine months of 1931 emigration was 22,769 greater than immigration, although for the year ending June 30, 1931, there was a net gain to our population of 35,257), Dublin, in an article on "Birth Control" in *The Forum* and *Century* for November 1931, claims that fertility and mortality in the United States are due to balance at 14 per 1,000 about the year 1970 (the 1931 crude birth rate was 19.8 per 1,000), when a life expectancy of 70 will have been attained (the current expectancy is 59).

Together with this assumption, and more particularly in the light of increasing urbanization, with its influence on the true rates, he estimates a maximum United States population of 148,000,000 (Fig. 3) to be reached by that year, with sharp declines thereafter until 140,000,000 is reached by the close of the century.

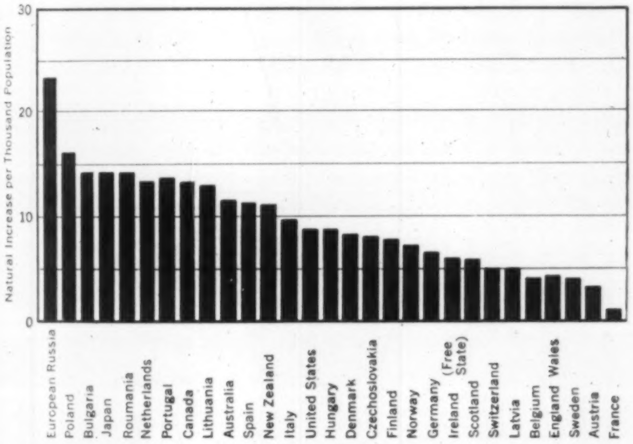


Fig. 2. Rates of Natural Increase in Population, Averages for 1928 and 1929

From the Report of the League of Nations, November 1931

Dublin's estimate is about 20,000,000 below the estimate predicted, according to Pearl and Reed's logistic curve for the United States for the year 1970. Allowing for a margin of uncertainty in any estimates of future population, it nevertheless becomes clear that competent statisticians are in agreement as to the marked trend toward a stationary state of our population, if indeed this has not been already relatively attained. In 1928 the true rate of natural increase was only 1.7 per 1,000, as contrasted with the crude rate of 7.9. Dublin's calculation for the year 1930 is a true rate of 0.

These trends are all the more evident when the vital statistics for the urban population are examined apart from those for the population in general. According to P. K. Whelpton of the Scripps Foundation for Research in Population Problems, as far back as 1920 the true rate of natural increase for rural native whites in the United States was +17.3 per 1,000 as against −5.6 for urban native whites. In 1920, when the effects of immigration were still potent, the true rate of increase for the native whites of Massachusetts, Connecticut, and New York (the three most highly urbanized states, which are 92 per cent urban) was −6.0 per 1,000 as against +13.6 for foreign whites in these states. By 1928, however, in these same states, in spite of their larger population, the total number of white births was 34,671 below the 1920 number. It is interesting to note that this loss was due to the falling off in the number of births to foreign-born women, which declined by 50,639, although this figure was partly offset by an increase of 15,968 in the births to native white women.

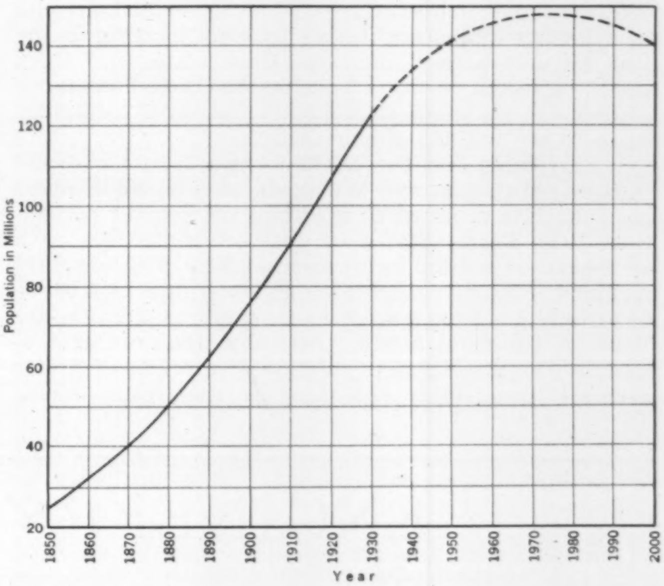


Fig. 3. Present Population of the United States and Probable Future Increase

Based on Estimates by Dublin and Lotka

The influence of urbanization is also largely responsible for this decline, as well as the passing of heavy immigration. In 1920 the foreign whites in these same three states, as well as in 11 of the largest cities throughout the land, although coming as adults from the high birth rate countries of the so-called newer immigration—that is, Italy, Poland, and Russia—had true rates of natural increase below the more rural foreign whites in Kansas, Minnesota, and Wisconsin, even though the majority in this latter group came from countries of low birth rates. This difference in the true rates of natural increase is in part accounted for by higher mortality rates among the immigrants dwelling in cities.

MIGRATION FROM RURAL DISTRICTS

The growth of cities is increasingly dependent on migration from the rural areas of the nation, made possible by a highly favorable rural excess. This situation is further revealed by an examination of the true rates for 1928. By that year, not only were the three northeastern highly urbanized states of Massachusetts, Connecticut, and New York well out of the class of states gaining by a surplus of births over deaths, but nine leading American cities—Baltimore, Boston, Cleveland, Detroit, New York, Philadelphia, Pittsburgh, San Francisco, and Washington, D.C.—had a true rate of natural increase among their total whites of -5.1. This means that if the 1928 specific birth and death rates continued in operation—and all the evidence points to a further diminution rather than an increase in the true rates of natural increase—these states and cities would be forced to draw from outside their boundaries in order to maintain their population on a stationary basis, to say nothing of increasing it.

Pennsylvania and the North Central States of Ohio, Indiana, Michigan, and Wisconsin have a small excess over the rate required to maintain the present population. The Pacific States are just below the line, with a true rate of natural increase of -0.3 in 1928. Strictly speaking, the only geographic divisions now capable of contributing a large surplus to the white population are those of the rural South. Although the true rate of increase for the Negro population of the United States declined considerably less than for the whites during the last decade, the Negroes are likewise approaching a stationary population.

Nor do cities abroad reveal any relatively higher reproductive capacities. A study of ten of the most important German cities in 1924, as quoted in Sorokin and Zimmerman's book, *Principles of Rural-Urban Sociology*, indicates that only one is growing because of natural increase as a factor paramount to migration. Thus the declining significance of natural increase as a factor in city growth is evident in Germany. Sorokin and Zimmerman's analyses of the data relative to Denmark, Sweden, and the urban provinces of Switzerland of late decades, as well as of the natural increase of London, Paris, and Berlin, indicate the marked diminution in importance of the factor of natural increase together with the increase in the rôle of migrations in accounting for growth.

It is becoming increasingly evident that the replenishment of urban populations is dependent on the surplus of population produced in rural areas that migrates to the cities. Furthermore, as the birth rates in these rural areas follow downward trends, future increase in the urban centers will be checked, if only from a gradual cessation of this rural surplus.

ENGINEERS' NOTEBOOK

From everyday experience engineers gather a store of knowledge on which they depend for growth as individuals and as a profession. This department, designed to contain practical or ingenious suggestions from engineers both young and old, should prove helpful in the solution of many troublesome problems.

Torsional Stresses in a Crane Support

By BRENT C. JACOB

MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
FORMERLY ELECTRICAL AND MECHANICAL ENGINEER, INDUSTRIAL BROWNHOIST CORPORATION, CLEVELAND, OHIO

IN the design of a braced structural steel tower with a locomotive crane on it, it became necessary to investigate the torsional stresses induced by rotating the crane. The forces acting on such a structure are resisted by several members and the problem is to determine the amount of resistance offered by each. The new method found for solving such a problem will be described, using as an example the structure illustrated in Fig. 1. This method of obtaining the stresses in a framed structure, where it is possible for the force to take several paths, is as accurate as the ordinary graphical stress diagrams used for trusses, where no notice is taken of rigid joints and deflection of parts.

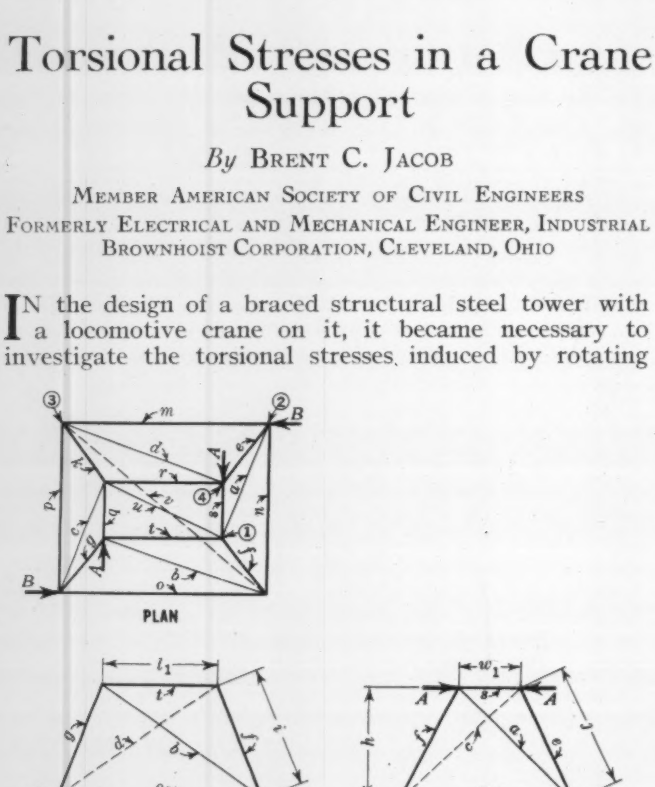


FIG. 1. A SYMMETRICAL TOWER RESISTING A TORSIONAL LOAD
Stresses and Dimensions Indicated by Letters

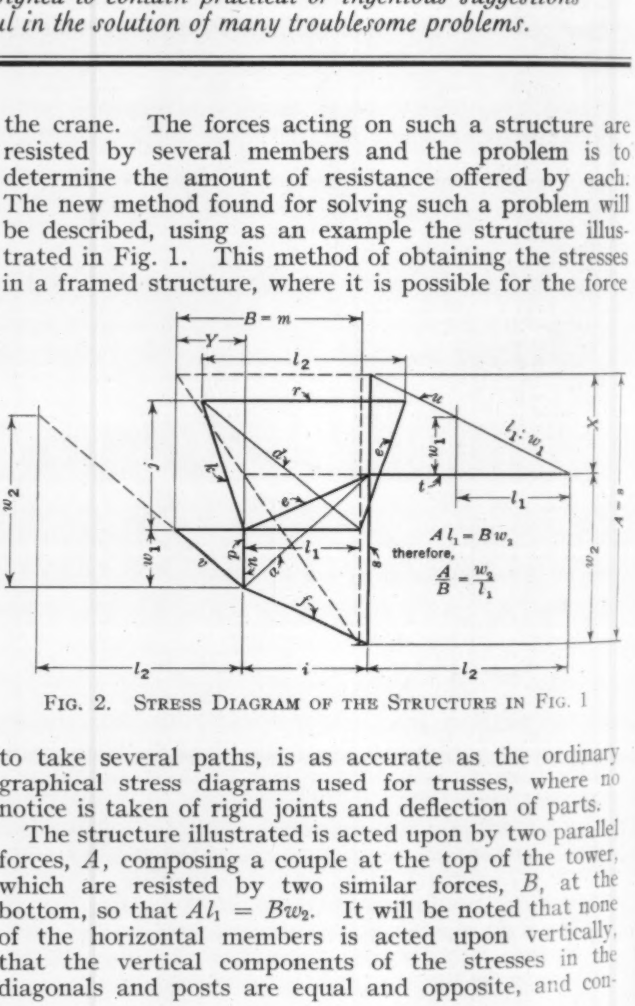


FIG. 2. STRESS DIAGRAM OF THE STRUCTURE IN FIG. 1

The structure illustrated is acted upon by two parallel forces, A, composing a couple at the top of the tower, which are resisted by two similar forces, B, at the bottom, so that $Al_1 = Bw_2$. It will be noted that none of the horizontal members is acted upon vertically, that the vertical components of the stresses in the diagonals and posts are equal and opposite, and consequently that the stresses in the diagonals and posts are proportional to their lengths. Diagrams can therefore be made using the lengths of members to represent their stresses.

First Fig. 2 is drawn, starting with w_1 and w_2, parallel to each other, and at the distance, i, apart, and joined by the lines f, a, and e. This gives the actual lengths of the end members and the angles of their intersections. The line t, equal to l_2, is then drawn, and also the line u, commencing at the outer end of t, and having a slope equal to the ratio, $l_1 : w_1$. The line u is extended till it meets the extension of the vertical line s, which is equal to the value of the force A, and gives the scale to use for the value of the forces in all the members. In Fig. 2, the length of the line marked by any letter represents the amount of the stress of the member marked with the same letter in Fig. 1. The remainder of Fig. 2 is constructed as indicated.

The truth of this stress diagram will be more evident by considering the forces acting at joints 1, 2, 3, and 4 of Fig. 1. These figures, 3(*a*), (*b*), (*c*), and (*d*), are part of Fig. 4, separated for clearness. At joint 1, members s, f, a, t, and u act to balance themselves, as shown in Fig. 3(*a*). At joint 2, members n, e, and a, in the end plane, balance one another, while force B is directly balanced by m. This is shown by Fig. 3(*b*). At joint 3, members k, p, v, m, and d balance, as shown by Fig. 3(*c*). Fig. 3(*d*) shows the balance of members r, e, and d at joint 4.

The values of A and B found by this construction are shown to be correct by the dotted triangles (Fig. 2) giving $\frac{A}{B} = \frac{w_2}{l_1}$. In the diagram, the forces in the diagonals and posts were made equal to their lengths. From Fig. 3(*b*) the value of n, which equals p, is found. Having obtained the values of the forces k, p, and d, the location of m, and the direction of v, Fig. 3(*c*) is easily constructed. This gives the values v and m, with $m = B$. Fig. 3(*a*) gives the value of A as soon as t or u is determined. That the derivation of Fig. 2 is consistent may be shown by a separate computation of the known relation $\frac{A}{B} = \frac{w_2}{l_1}$, as follows:

By construction:

$$A = w_2 + X, \text{ and } B = l_1 + Y$$

$$\text{but } X = \frac{l_2 w_1}{l_1} \text{ and } Y = \frac{w_1 l_2}{w_2}$$

$$\text{Then } A = w_2 + \frac{l_2 w_1}{l_1} = \frac{l_1 w_2 + l_2 w_1}{l_1}$$

$$\text{And } B = l_1 + \frac{w_1 l_2}{w_2} = \frac{l_1 w_2 + l_2 w_1}{w_2}$$

$$\text{Therefore } \frac{A}{B} = \frac{w_2}{l_1}$$

Hence the value of t and u may also be taken from Fig. 2.

The length s is now scaled and called A pounds, which gives the proper scale for measuring the stress in all the members. This can be readily done by proportion on the slide rule, and the values can be noted in a table or on each member. This method of analysis can be extended to find the stresses in various structures of a similar type.

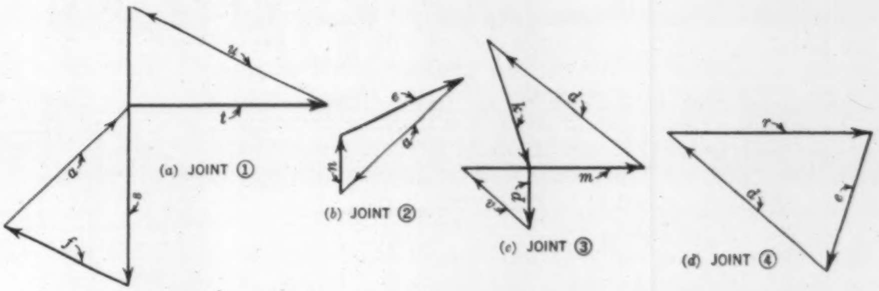


Fig. 3. Stresses at Joints Marked *1*, *2*, *3*, and *4* in Fig. 1
These Have Been Separated from the Stress Diagram, Fig. 2, for Clarity

Chart for Setting Progressive Traffic Signals

By Frederick L. Mosher *and* Gilbert Robinson

Boston, Mass.

THE graphical method here described was designed as an aid to the traffic engineer in determining the speed or the time interval in the setting of progressive traffic signals. The labor of computation, either in the office or the field, will be greatly lessened by the use of the chart given in Fig. 1. The formula on which this chart was designed is based on the principle that distance divided by rate equals time.

The application of the chart is illustrated by the following example. Assume that the distance between intersections is 700 ft and that the speed desired is 29 miles per hr. Find the time interval for the setting

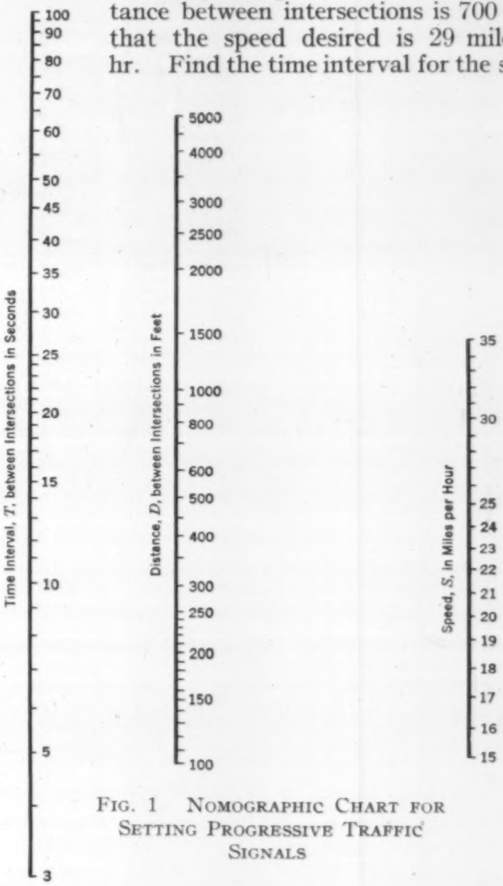


Fig. 1 Nomographic Chart for Setting Progressive Traffic Signals

of the traffic signal. By means of a straight line, connect the point representing 29 miles per hr with that representing a distance of 700 ft, and produce this line to intersect the time interval scale. On this read 17 sec.

Take another example, in which the distance between intersections is 1,500 ft and the time interval needed to coordinate with the progressive flow on the cross street is 30 sec. Find the speed to be observed.

Connect by a straight line the point representing the time interval of 30 sec with that representing the distance of 1,500 ft, and prolong this line until it intersects the third scale at 33 miles per hr.

Welded Steel Roof Trusses Economical

By J. E. WEBSTER

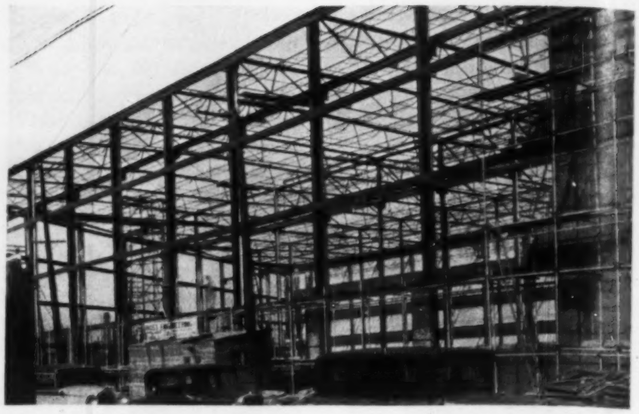
GENERAL WORKS ENGINEER, WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, EAST PITTSBURGH, PA.

TWO buildings recently erected by the Westinghouse Electric and Manufacturing Company at Derry, Pa., and Mansfield, Ohio, well illustrate the great economies that can be obtained by using welding in steel fabrication. The Derry building has 30 trusses 30 ft long and 10 trusses 52 ft long; and the structure at Mansfield has 42 trusses each 64 ft 6 in. long. If standard practice had been followed, girders would have been used in the building at Derry.

In Table I are given the weights of the trusses actually used in the two buildings as contrasted with the weights of the girders or trusses that would have been used if standard practice had been followed. In each case the trusses were designed to carry a total load of 800 lb per lin ft, the loads being concentrated at the panel points. Comparative costs are difficult to obtain, but it is safe to say that the new trusses can be fabricated at as low a cost per pound as the heavier conventional trusses.

FULL LOAD TEST ON 52-FT WELDED TRUSS AT DERRY, PA.

The novel feature of the welded truss is that all tensions in it are segregated and carried by continuous steel members bent to follow the stresses. Thus in the 64-ft trusses used at Mansfield, shown in Fig. 1, there are four straps, *a*, *b*, *c*, and *d*, which take care of all the tension. If the struts are so placed as to bisect the angle between the diagonal and the lower chord, the tension in each strap is uniform for its whole length.



WELDED ROOF TRUSSES IN PLACE AT MANSFIELD, OHIO

TABLE I. COMPARISON BY WEIGHT OF WELDED AND STANDARD DESIGNS

LENGTH OF TRUSS	NEW DESIGN	STANDARD CONSTRUCTION
Building at Derry:		
30 ft	520-lb welded truss	1,200-lb girder
52 ft	1,550-lb welded truss	4,420-lb girder
Building at Mansfield:		
64 ft 6 in.	2,400-lb welded truss	3,600-lb standard truss

Of course the straps are bent at the lower ends of the struts, so that there is no joint to make between the diagonals and the lower chord, which is made up of the straps themselves. It is also apparent that all members other than the top chord can be the minimum weight allowed by the fiber stress limitation of 18,000 lb per sq in. This minimum weight can be used not only because of the uniform loading, but also because in welded trusses no deduction need be made for rivet holes. Also it is not difficult to make the connection to the top chord as strong as the strap. The welds at the ends of the struts are merely to keep them in place. This type of truss can be used for roofs, trestles, bridge approaches, and in some cases for bridges.

Full load tests were made on two of the 52-ft trusses used at Derry, of the slightly different design shown in the photograph. The calculated deflections and stresses were verified by measurements of the loaded truss.

Welding allows the designer to match the steel to the stresses, since members can be joined at any angle with no reduction in the section strength.

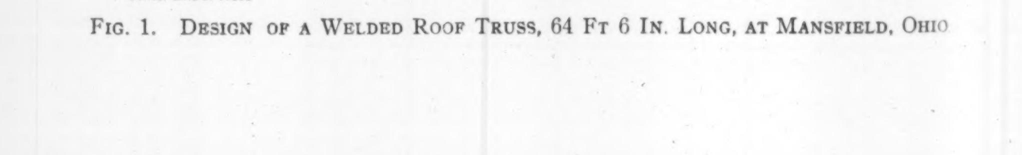


FIG. 1. DESIGN OF A WELDED ROOF TRUSS, 64 FT 6 IN. LONG, AT MANSFIELD, OHIO

OUR READERS SAY—

In Comment on Papers, Society Affairs, and Related Professional Interests

Paving and Public Utilities Construction

To the Editor: In his article in the March issue, Mr. Whitehurst sums up the entire question of control of pavement cuts in the one sentence, "The real solution of the problem lies in careful planning before the pavements are laid, rather than in attempting to prevent or minimize subsequent street openings by means of heavy penalties or fees."

A street is a right of way for transportation, whether it exists for the movement of commodities or passengers over its surface or for the movement of water, sewage, gas, or other utility service in conduits beneath its surface. The underground use of a street is as essential to the well being of a community as its surface use. Any punitive fees for cutting pavements or prohibitive regulations restricting cuts hamper the free development of subsurface utilities, and to that extent retard the availability of that service to the community. There is a tendency in some cities to evade the responsibility of properly controlling cuts in pavements by prohibitory regulations, which may in effect partially confiscate property by preventing, or at least delaying, its most profitable use. The detrimental effect of such regulations on the municipal government is twofold: first, the loss of revenue that would accrue from the increased assessment on the improved property; and second, a dissatisfied citizenry who feel that their rights have been unnecessarily curtailed by purely arbitrary restrictions.

Since 1923 the City of Milwaukee has had a planning division in the Department of Public Works. One of the duties of this division is to coordinate all work done on city streets. The annual paving program is adopted sufficiently in advance of the construction season to allow the public utilities and various city departments to adapt their construction programs to the paving schedule, which is the controlling feature of the entire improvement program. All underground construction is completed before the pavement is laid. As a result of this coordination, requests for permits to cut pavements are reduced to a minimum. These requests may be arranged in the following groups: (1) emergency repairs to existing underground structures; (2) enlargement of connections due to change of use of abutting property; and (3) unanticipated demand for expansion or extension of utility services.

It is obvious that the denial of permission to cut through pavements for any of these purposes would be unwarranted. The fees charged for permits are based entirely on the cost of pavement replacement, there being no item of penalty included in them. The careful administration of a fair policy protects the interests of the municipality without discouraging the natural growth of the city.

Raleigh W. Gamble, Assoc. M. Am. Soc. C.E.
Superintendent of Street Construction and Repairs, City of Milwaukee

Milwaukee, Wis.
March 31, 1933

Use Should Determine Navigability

Dear Sir: The article on "What Is a Navigable Waterway?" by General Pillsbury, in the March issue, is most timely and informative. In the light of our present development, the aspect that should perhaps be emphasized is, "Why is a navigable waterway?"

As stated in the paper, navigable waterways were, before the development of our modern land highway system, the highways of communication and commerce. The larger waterways remain so, but the smaller ones have become obsolete for that purpose and a great many of them now carry no traffic. Land traffic has so increased in volume and importance, with relation to the maximum traffic that the waterways ever carried, that it may well be considered of paramount interest, yet with a very few exceptions the very insignificant use of the waterways still has a preferential right.

Again we find governmental rulings to the effect that pipe lines and other public utilities crossing small streams—which in the past were used for traffic but are no longer so used, except perhaps very occasionally for a light-draft barge or launch—must be placed more than 20 ft below the natural stream bed, presumably with the idea that these streams might possibly be dredged to greater depths at some future time. We even find that projects for such dredging operations are still being presented to the Government, with request that it spend considerable sums of public money for these so-called improvements. Happily these "pork-barrel projects" do not find the ready approval they once did, thanks to the efficient work of the U.S. Corps of Engineers.

"Why is a navigable waterway?" should find its answer in fact. The relative importance of the waterway as an economic factor in transportation should be considered, and its preferential rights should be ordered accordingly.

Arthur S. Hobby, M. Am. Soc. C.E.
Consulting Engineer

Newark, N.J.
March 22, 1933

Physical Stream Characteristics Indicate Navigability

To the Editor: Definitions of navigable waterways are limited largely to court decisions, mostly based on the nature and extent of past use rather than upon susceptibility of use as a highway for commerce. Discussing this subject in the March issue, General Pillsbury states that, "It is not possible to fix a standard of size and character of a stream or of its slope, velocity, or discharge as a criterion of navigability. . . ."

While it is true, as stated by the U.S. Supreme Court in a recent decision, that "Each determination as to navigability must stand on its own facts," I suggest that when evidence of actual use is lacking or meager in amount, susceptibility of use might well be determined by a consideration of the physical characteristics of a stream, such as slope, velocity, discharge, and character of stream bed, and by a comparison of these data with like characteristics of other streams, which have already been classified as navigable or non-navigable.

This method is approached in the decision of the U.S. Supreme Court in the case of the United States vs. the State of Utah, rendered April 13, 1931, determining the navigability of certain portions of the Green, Colorado, and San Juan rivers in Utah in 1896, the year Utah was admitted to the Union. This case, brought by the United States to establish its title to the beds of certain parts of these streams, is unusual; the United States argued that the reaches in controversy were not navigable while the state contended that they were navigable. Neither side was interested in the use of these rivers as highways of commerce, but both desired to control prospecting for petroleum, oil, and gas in the river beds.

Green River, at its junction with the Grand, has a drainage area of 45,000 sq miles and a mean annual run-off of 7,915 cu ft per sec. The discharge measured 95 miles upstream exceeds 2,000 cu ft per sec for 290 days and exceeds 4,200 cu ft per sec for 149 days. The average slope in the intervening reach is 1.18 ft per mile, and the course of the river is very tortuous, being more than twice the air-line distance. The river is a heavy carrier of silt, and the chief obstacles to its use are the sand bars characteristic of such streams. The width varies from 500 to 700 ft.

The Master in his report to the Supreme Court set up another physical characteristic, that is, the average depth at the gaging station, finding that it ranged from $1^1/_2$ to 3 ft for 53 days in the year, between 7 and 12 ft for 60 days, and that for 312 days there was an average depth of 3 ft or more in that cross section. He found that drift and high water velocities did not constitute serious obstacles to navigation, that ice periods did not prevail every winter, and that they were shorter than on most rivers in the northern and northeastern states of the country.

Based upon this showing, the lower 95 miles of the Green River were declared to be navigable in 1896, and control over the bed passed from the United States to Utah when that state was admitted to the Union. The navigability of the remainder of the Green River was not in controversy, as both parties apparently accepted its non-navigable status. By way of comparison, however, the Master and the Court noted that the 504-mile reach from Green River, Wyoming, to Green River, Utah, has an average fall of 5.2 ft per mile. While not conclusive, such a slope in a stream of similar magnitude and character might well be cited as evidence of non-navigability. Similar findings were made with respect to the sections of the Grand, Colorado, and San Juan rivers under consideration.

This case is brought to the attention of the Waterways Division in the belief that it marks a forward step in the determination of the boundary line between state and national control of the rivers of the United States and that engineering comparisons of physical characteristics will play a more important part in future decisions than they have in the past.

C. W. KUTZ, M. Am. Soc. C.E.
Brigadier-General, U.S.A. (Retired)

Washington, D.C.
March 4, 1933

Areas Between Eccentric Circles

DEAR SIR: Mr. Clair's solution by calculus of the problem involving two non-concentric circles, which appears on page 172 of the March issue, is of interest, but it should be observed that the problem can readily be solved by mathematical processes in more general use: by algebra, geometry, and trigonometry. In the accompanying sketch, Fig. 1, the center of the larger circle is the origin of rectangular coordinates; and the radii of the two circles, the distance between their centers, and the slopes of the straight lines *DB* and *DC* are known. It is evident at a glance that, if the coordinates of the points *B*, *C*, and *I* can be found, the rest of the solution will be very simple. The successive steps in the solution are as follows:

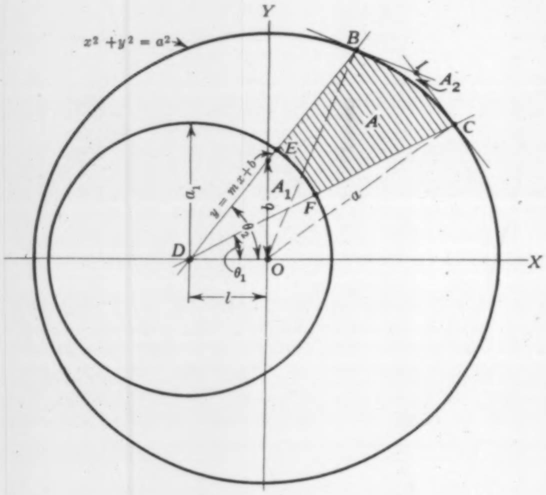


FIG. 1. SOLUTION FOR SECTOR AREAS WITHOUT CALCULUS

1. Write the equation of the larger circle, $x^2 + y^2 = a^2$, and the equations of the lines *DB* and *DC* in the well known form, $y = mx + b$. Then solve simultaneously in turn the equation of each of the straight lines with the equation of the circle. These solutions will give the coordinates of the points *B* and *C*.

2. Draw the radii *OB* and *OC*; also draw the lines *BI* and *CI* tangent to the larger circle at the points *B* and *C*, respectively. Write the equations of the lines *BI* and *CI* and solve them simultaneously for the coordinates of the point *I*.

3. Compute the area of the quadrilateral *OBIC* and deduct from it the area of the sector *OBC*. The remainder will be the small area lying outside the larger circle, designated as A_2.

4. Compute the area of the quadrilateral *DBIC*, and then compute that of the small sector *DEF*, designated as A_1. Deduct A_1 and A_2 from the area of the quadrilateral *DBIC*, and the remainder will be *A*, shown by the shaded area on the sketch.

ROGER B. MCWHORTER, M. Am. Soc. C.E.
Chief Engineer, Federal Power Commission

Washington, D.C.
March 8, 1933

Stirrup Spacing at Foot Intervals

DEAR SIR: The article by Mr. Burmister, in the January issue, on "Stirrups for Reinforced Concrete Beams," is very interesting. However, the practicality of spacing several stirrups the same distance apart, before changing to another spacing, permits of investigation for shear at 1-ft intervals along the beam.

The standard stirrup spacing formula (given by Taylor, Thompson, and Smulski, in *Concrete, Plain and Reinforced*, Vol. 1, page 898) is:

$$s = \frac{A_v \ f_s}{\dfrac{V'}{jd} - vb} = \frac{A_v f_s jd}{V' - vbjd} = \frac{\text{“}B\text{”}}{V' - \text{“}C\text{”}}$$

A table may be made for resulting values of this fraction, since "*B*" and "*C*" become constants where any definite size of beam is chosen. Then (1) referring in such a table to the proper size of beam, the hair line of the runner on the slide rule is set to the value "*B*," and is kept in this position; (2) subtract "*C*," found in the table, from the end shear *V'*, and divide this value into "*B*" to find the stirrup spacing for the first foot of beam length; and (3) from the value of the denominator determined in (2), subtract the uniform load per foot of beam, and divide the result into the value "*B*" as before, which gives the stirrup spacing for the second foot of beam length.

This procedure is continued until the shear value to be cared for by the stirrups becomes equal to, or less than, the uniform load per foot. It should be noticed that this method is applicable whether or not the plane of zero shear is at the center of the beam.

To illustrate its simplicity, the stirrup spacing, *s*, is calculated for the same beam and loading used by Mr. Burmister. Then $b = 8$ in., $d = 19$ in., and span = 12 ft, $^1/_4$-in. round stirrups being used. Assume that $v' = 93$ lb per sq in. and that $v = 40$ lb per sq in.; then the end shear $V' = 93 \times 8 \times {^7/_8} \times 19 = 12{,}350$ lb, and $w = 2{,}060$ lb per ft.

From the formula, $s = \dfrac{26{,}030}{V' - 5{,}320}$

12,350
5,320
7,030......first foot, $s = \dfrac{26{,}030}{7{,}030} = 3.7$ in.; use 3-in. spacing.
2,060
4,970......second foot, $s = \dfrac{26{,}030}{4{,}970} = 5.25$ in.; use 5-in. spacing, etc.

Place the first stirrup 2 in. from the support, then 4 spaces at 3-in., then 2 spaces at 5 in., etc.

The procedure is essentially the same in the case of beams with concentrated loads, it being often only necessary to apply the formula for *s* at the ends of the beam, and at the points where the concentrated loads occur.

When specifications call for the bent-up bars to be used to take their part of the diagonal tension, a saving in the number of stirrups is obtained, since they can be omitted over three-quarters of the length of the sloping portion of the main bars. In this case, of course, the points of bending must agree with the stirrup spacing formula.

J. R. MORTON, JR., Assoc. M. Am. Soc. C.E.
Designing Engineer, U.S. War Department

Washington, D.C.
March 23, 1933

Flat-Slab Construction for Bridges

To the Editor: The article by J. L. Vogel, in the March issue, brings out clearly the economic advantages of flat-slab construction in certain bridges. The City of Denver, Colo., has built a number of this type, based on my designs, and has considered its experience entirely satisfactory.

As long ago as 1912 this type was adopted for the Market Street and the Larimer Street bridges over Cherry Creek, in competition with concrete and steel, and concrete arch designs. Aside from economy, the factor of 10 per cent additional clear waterway was an inducement for adopting the flat-slab construction. A disastrous cloudburst came just at a time to emphasize this feature and clinched the decision. Similar construction was adopted in 1913 for the Curtis and Downing Street crossings, and in 1919 for the West Colfax and Logan Street structures. Some of these bridges were skewed as much as 30 deg. Skew designs are easily handled in flat-slab construction.

Still other interesting examples of this type of construction have come within my experience, notably for the deck of the Fort Snelling-Mendota Bridge, Minnesota. Engineers have been slow to adopt this type of construction, which is strange in view of its great economic advantages in many situations. I am now designing flat slabs without concrete column capitals or floor depressions. This improvement increases the overhead clearances. Steel columns may readily be used with this type of design to increase the lateral clearances between supports.

The article by Searcy B. Slack, in the April issue, discusses temperature stresses in bridge floors, which consist of combinations of thin slabs and heavy beams and girders. It is obvious that temperature stresses that exist in bridge floors of flat-slab construction are more evenly distributed and less objectionable.

Walter H. Wheeler, M. Am. Soc. C.E.
Designing and Consulting Engineer

Minneapolis, Minn.
April 6, 1933

Erosion from Overgrazing Small

To the Editor: Professor Chapman's article, in Civil Engineering for February, presents an impression of the effect of overgrazing on erosion on the open public domain not in harmony with the views of those whose business it is to study the agricultural and grazing utility of that domain.

Professor Chapman asks "Has this phenomenon [overgrazing of the open public domain] been accompanied by increased erosion, and, if so, to what extent?" He then proceeds to answer his own question by citation of instances of relatively recent erosion, and by statement or inference draws the conclusion, totally unwarranted by the evidence cited, that overgrazing is the cause of the erosion. One would scarcely be inclined to dispute the fact that the white man's occupancy of the West, with whatever overgrazing of the range country has occurred, has been accompanied by erosion. Erosion preceded man's advent on the earth and has accompanied his sojourn there. A large number of his activities tend toward accelerated erosion while others have the opposite effect. In the absence of reliable statistical information, it is uncertain whether the net effect of man's activities is favorable or unfavorable to erosion, and it is debatable as to the relative position of overgrazing among the several activities of man that tend to promote accelerated erosion.

Wyoming in 1869 Showed Evidence of Prior Erosion
Grazing Animals Can Affect This Vegetation but Little

It should be borne in mind that on the open public domain, which is Professor Chapman's principal theme, a vegetal density of three- or four-tenths is about the upper limit; that over extensive areas, vegetation covers less than 10 per cent of the surface; that, in general, there is no mat of grass or sod, most of the ground surface being naturally bare; and that only a part of the remainder bears suitable forage for stock. Overgrazing can therefore add little to the erodible area.

Lake Shore Terraces on the Border of Great Salt Lake Basin
Terraces Are Especially Susceptible to Erosion, and These Have Not Escaped

The Manti Forest experiments, cited by Professor Chapman and reported in Technical Bulletin 220 of the U.S. Department of Agriculture, may properly be considered as suggesting that there may be slightly increased run-off and definitely increased erosion of no great amount with decreased vegetal cover. Although the percentages cited by Professor Chapman express correctly the arithmetical relations of certain sets of figures in the report, they are substantially meaningless, because of wide differences in topography, shape, and cover of the areas studied and in meteorological conditions during the several periods of observation. For example, four storms with precipitation of an inch or more occurred during the first or "overgrazed" period of observation, and none of such intensity during the later or "restored vegetation" period of observation. The author of the bulletin referred to, C. L. Forsling, himself a missionary in the field of grazing as a cause of erosion, is constrained to conclude, "that under the conditions of soil, relief, and climate affecting the present experimental areas, measures that will restore and maintain the maximum plant cover for grazing purposes will also insure adequate watershed protection except in some of the more extreme cases." This moderate and conservative conclusion is in line with the opinion of engineers who have had considerable experience with problems and conditions of the public domain.

The attitude of many engineers on the question of grazing control is expressed in the report of a committee of American Engineering Council which, in considering the report of President Hoover's Commission on the Conservation and Administration of the Public Domain, stated the following principle, which has been approved by the American Engineering Council:

> "Grazing lands should be placed under control and regulated and administered by a responsible agency and in a scientific manner. Range control, analogous to that of forest control, should be established."

Wm. H. Richards, Jr., M. Am. Soc. C.E.
Cadastral Engineer, Division of Surveys
General Land Office

Washington, D.C.
March 10, 1933

Fantastic Notions of Erosion

TO THE EDITOR: Those who take their publicity propaganda seriously will find in the "Influence of Overgrazing on Erosion and Watersheds," in the February number, another of those timely articles written so that "he who runs may read." He may not fully understand, but he gets a vague impression that the West is being utterly ruined because of the millions of half-starved sheep and cattle trampling each other in a frenzied search for the few sprigs of grass or sage still remaining on storm-gullied slopes, where but a generation ago was a cow's paradise of undulating hills protected from erosion by a veritable mat of succulent forage grasses. He decides that something must be done about it and so writes his Congressman.

There is a silt problem, of course, as regards the filling of reservoirs, the maintenance of irrigation systems, and the loss of soil from cultivated fields, but grazing on the public domain has very little to do with it. If grazing is regulated solely for the purpose of providing food for stock, the problem of erosion on the public grazing lands will be automatically cared for and may be forgotten.

The prevalence of luxuriant grasses on a friable soil is recognized as a great aid in preventing erosion. As aridity increases, however, the grass growth becomes scantier and has diminishing efficacy, until on many large drainage areas of the West there is no vegetation of any kind. In fact, there probably never has been any vegetation on many such areas since the glacial epoch and there probably never will be any again.

I am just as heartily in favor of intelligent national control of grazing areas as of National Forests, but not for the reasons often given. There is every reason for such control from the standpoint of lumber supply, recreational and esthetic gratification, and on grazing areas for the conservation of food for stock. I am, however, quite satiated with the "no-forest-no-rivers" hoax and now the "no-grazing-for-silt-control" campaign. By all means let us investigate the origin of silt and the means for its control, but let us do it in the name of science and not of political expediency.

If Professor Chapman had told the entire story about Chaco Canyon, he would have pointed out that the arroyo now being cut in that valley has uncovered another arroyo that had been cut at some previous period and had silted entirely full again. There is also an arroyo being made in the valley of the Rio Puerco and in the Zuni River valley—in fact, in most of the ephemeral stream valleys of the Southwest. Before white settlers became numerous these valleys had discontinuous channels. A degrading process began from 50 to 100 years ago at the mouth and cut back toward the headwaters. On the Rio Puerco this arroyo is now about 150 miles long and is widening with every flood. It will doubtless continue the widening process until a layer of alluvial silts some 20 ft in thickness has been removed from the valley floor. This however is no reason for flippantly assigning overgrazing as the predominating cause.

In Chaco Canyon particularly, and no less plainly in the others, is written the history of at least one preceding period of degradation that most certainly was not caused by overgrazing, because the Indians, as Professor Chapman so aptly points out, had no grazing herds.

J. C. STEVENS, M. Am. Soc. C.E.
Stevens and Koon, Consulting Engineers

Portland, Ore.
March 29, 1933

Reservoir Silting and Soil Erosion

TO THE EDITOR: The article, "Influence of Overgrazing on Erosion and Watersheds," by Professor Chapman, in the February issue of CIVIL ENGINEERING, serves to call to the attention of the engineering profession the problem of silting of storage reservoirs in the Southwest.

In Southeastern reservoirs the loss of storage capacity resulting from silting—except in such striking cases as the Zuni Reservoir in New Mexico—has not been such as to give cause for worry from the standpoint of reduction of yield, because the total loss of capacity which has occurred during the past 10 or 20 years has not been great in the aggregate. Likewise the total reduction in capacity from silting will not have reached serious proportions by the time the bonds, by means of which the project was built, have been completely retired.

When one considers the useful life of 140 years for storage reservoirs—as in the case of Elephant Butte, and of double that period for the Hoover Reservoir on the Colorado River—one wonders what will become, by the year 2400, of the thousands of acres under irrigation in New Mexico and Texas that have been developed as a result of the Elephant Butte Project, and of the millions of inhabitants and billions of investment in southern California that depend upon the Hoover storage reservoir.

Three courses appear available to maintain the yield of these reservoirs. The first is to add to storage capacity in the future by raising the height of dams. By the year 2400, engineers will undoubtedly be able to build, safely and economically, dams of greater height than that of Hoover Dam, but the increased storage facilities will be in area rather than depth, and consequently subject to greater evaporation losses, with a resultant decreased yield per unit of storage capacity. A second course is the development of additional storage of adequate size at other sites on the watershed, working progressively upstream until storage is ultimately located almost entirely in the headwater section, which is above the area of watershed furnishing major silt contributions. However, there are many small storage reservoirs where this remedy cannot be applied. The third course is that suggested by Professor Chapman, of reducing erosion through a scientific study of the problem. Even if the results of such study merely cause a material reduction in silt capacity, the life of storage basins will be greatly increased.

Sheep raising in the Navajo country had not been practiced, to any appreciable degree, before the last decade of the last century. In the nineties, however, the Navajos introduced large herds of sheep and goats. Many white men living in this region at the time of my work there, during the period from 1913 to 1916, recalled the time, from 15 to 25 years previous, when ravines 50 ft deep either did not exist or were in the form of a low swale, which could be crossed by a wagon. Rainfall records for Arizona do not indicate any marked increase in precipitation for the 25-year period preceding 1913, so it would appear that increased erosion was due essentially to increased grazing by sheep and goats. The harmful results of increased grazing appear to come, not alone from the consumption of grasses by these animals, but also from the fact that soil and grass cover are cut up by their small feet.

Although little is known of this subject at the present time, it is of sufficient importance to the future of civilization in the Southwest to warrant intensive study and research.

DONALD M. BAKER, M. Am. Soc. C.E.
Consulting Engineer

Los Angeles, Calif.
March 23, 1933

Floods in Well Forested Regions

TO THE EDITOR: Professor Chapman, in CIVIL ENGINEERING for February, draws inferences and conclusions as to certain phenomena in Utah that seem wholly unwarranted on the basis of known facts.

He speaks of the testimony of Prof. Reed W. Bailey (before "a Senate Committee" unidentified) on the subject of floods between Salt Lake City and Ogden, Utah. These have often been cited in the overgrazing-erosion propaganda. He states, "In the summer of 1932 [Bailey, Committee on the Public Lands, H.R. 72d Congress, 1st Session, on H.R. 11816, May 31, 1932, correctly sets the date as 1930], in the section between Ogden and Salt Lake City, over a dozen [Bailey says four] floods occurred, . . . These floods originated on the denuded upper limits of the slopes in gullies, which opened up where heavy overgrazing by sheep and cattle had removed most of the plant cover."

This gives the impression that the floods originated as a result of overgrazing, although it does not actually say so. Bailey, in the same reference, states, "Those bare areas occupied only a small per cent of the total watershed." A sensible statement would be that heavy rain on the mountain resulted in floods that caused serious erosion in the rocky fans at the mouths of certain stream canyons; that small, bare, overgrazed areas, where the rainfall was heaviest, suffered some erosion of soil; and that eroded material (boulders from the rocky fans rather than soil from the bare areas) did considerable damage to occupied lands below. The total quantity of water involved was small, but it was confined in a narrow precipitous canyon and debouched upon the fan with great force.

A much more serious occurrence is reported by Kinnison (Water Supply Paper 636(c), U.S. Geological Survey). In the State of Vermont alone the damage was placed at $28,000,000, and the loss of lives totaled 84. Kinnison says "Floods on streams in New England during November 1927, were caused by excessively heavy rains falling on ground that was well saturated." Even well forested Vermont with its heavy vegetal cover, where overgrazing is unreported, has its problems of flood and erosion.

According to Follansbee and Jones (Water Supply Paper 487, U.S. Geological Survey), in June 1921, cloudbursts producing a flood volume of less than 90,000 acre-ft caused damage near Pueblo, Colo., in excess of $19,000,000. That overgrazing was not a factor in this is attested by the fact that an even higher flood occurred prior to settlement by white men, probably in 1844, and that floods of similar character and intensity have been caused by cloudbursts on one or another of the foothill tributaries of the Arkansas at irregular intervals before and since.

The western slopes of the Wasatch Plateau in Utah, like the foothills of the Rockies in Colorado, provide favorable conditions for cloudbursts. Their occurrence is inevitable and their intensity, irrespective of overgrazing, will determine the volume and intensity of resulting floods. If man places improvements in the logical flood path, damage will be done.

Ralf R. Woolley
Secretary, Utah Society of Engineers

Salt Lake City, Utah
March 14, 1933

Climatic Eccentricities Initiate Abnormal Erosion

To the Editor: In the February issue, Professor Chapman under the title, "Influence of Overgrazing on Erosion and Watersheds," discusses conditions in a public domain region, the location of which is not clearly defined. He claims that overgrazing of these public lands has caused widespread reduction in the carrying capacity of the range and often total destruction of forage plants or vegetative cover. He states that this overgrazing has been accompanied by increased erosion, which has "violently disturbed" the balance of nature and in one locality "moved a thousandfold more soil in fifty years than in the preceding ten centuries."

Scant Vegetation and Intensive Erosion
Wyoming in 1869

In so far as the foregoing statement correctly presents the views of Professor Chapman, they represent a likeness, true as to feature but exaggerated in detail—a cartoon, if you please—of the faithful and accurate delineation of conditions on the public domain, as disclosed by the protracted fact-gathering in which I have been actively engaged for a period of 20 years. The article contains examples of excessive erosion of a type that occurs commonly within the area presumably covered by the discussion and asserts that the "only operative cause" thereof is overgrazing. The instances cited are not fairly or even approximately representative of average erosion conditions on the open public domain, and in even these extreme instances there is no conclusive evidence of the amount of erosion attributable to man's activities. On most of the open public domain the only measure of damage from overgrazing is reduced carrying capacity of the range. The economic loss to the live-stock industry is not inconsiderable, but in general is the only avoidable loss worthy of material consideration.

Grazing Lands in Albany County, Wyo., About 1870

The change in stream habit in the public domain region cited by Professor Chapman as evidence of accelerated erosion can be ascribed, at least in many instances, as mainly or even wholly the result of natural laws. There can be traced in this region alternating periods of aggradation and degradation, which are known to have been repeated both before and since grazing was extensively practiced. Such changes occurred during the occupation of the Chaco Canyon region by a prehistoric Pueblo people who, according to Professor Chapman, "had neither cattle, sheep, nor horses," and are occurring today.

The article contains phrases pregnant with dire forebodings of disaster from erosion. To envisage any such disaster as a result of overgrazing on the open public domain seems to transcend the power of rational thinking. Explorers who visited the region long before the advent of domestic live stock wrote descriptions of sparse vegetation that are accurate pictures of present-day conditions.

The public domain as a whole has the characteristics of an arid region. Violent changes are caused in such a region by the sudden release of the accumulated potential energy of natural forces made operative largely through climatic eccentricities. The resulting disturbances often set in motion forces that will affect the landscape by progressive stages sometimes extending over a long period of years and into remote localities.

John F. Deeds
Chief, Agricultural Division
U.S. Geological Survey

Washington, D.C.
March 20, 1933

Deep Tunnels in Rock

To the Editor: I should like to comment briefly on the paper, "Deep Tunnels for the Delivery of Water Supply," by Mr. Spear, in the March issue. Tunnels in rock have been used for aqueducts since early times. They were constructed by the Romans, Greeks, and Persians, but the use of pressure tunnels, or those constructed under very heavy unbalanced heads, is peculiar to the Catskill Aqueduct and its delivery tunnels in New York City.

These tunnels are nearly always located in rock of sufficient strength to take up the unbalanced internal water pressure through the plain concrete lining. It is not the thickness of the concrete lining that is of great importance, but the strength of the rock backing. Where this has been insufficient, yielding occurs and cracks open in the lining, allowing large leakage. Provisions were made so that various sections of the tunnels could be tested under full internal pressure, then unwatered and the weak sections repaired, usually by installing a steel interlining. Thus over 40 miles of deep pressure tunnels were tested and only a few hundred feet of lining found weak, with considerable leakage. These stretches were readily repaired, and an immense saving was effected over the cost of lining a tunnel with steel throughout its entire length.

The defective sections were found in various kinds of rock—the worst in "cavy" limestone massive beds, having seams filled with soft clay. Another stretch was in an apparently sound granite, but there was insufficient cover. A third stretch was in schist, which had been altered by solution into talc and serpentine. The general lesson to be learned from this is to locate pressure tunnels deep in the rock from 400 to 500 ft below the surface, in rock not subject to decomposition. Shafts can be sunk to great depths and tunnels driven so rapidly as to permit of wide spacing of the shafts, which are expensive. This process presupposes a thorough study of the geology of the rocks by means of numerous borings interpreted by competent geologists. The strata penetrated by various deep pressure tunnels on the Catskill Aqueduct comprised sandstone, shale, limestone, granite, schist, gneiss, and other rock. All of these proved suitable, except where they were decomposed or had open seams permitting movement of the rock backing the concrete lining.

Under great internal stress, "popping" rock strata, as well as decomposed rock, cause trouble. These strata are usually found in apparently sound rock at depths of 600 ft and over.

LAZARUS WHITE, M. Am. Soc. C.E.
President, Spencer, White and Prentis, Inc.

New York, N.Y.
March 28, 1933

Sacramento Uses Wooden Tanks in Alum Manufacture

TO THE EDITOR: In connection with the article by Mr. Armstrong, in the March issue, describing the process of manufacturing alum, it may be of interest to consider the process in use at the Sacramento, Calif., water treatment plant. The Sacramento digestion tanks are made of redwood as contrasted with the steel construction used for the tanks at the Montebello Filters. The staves are of 3-in. stock carefully dressed and fitted. The hoop rods are kept away from the outside faces of the staves by wooden blocks bearing against the tank side, so that the metal is protected from corrosion from any accidental dripping down the outside of the tank. Although it is possible that a wooden tank, on account of its relative interior smoothness and freedom from heat expansion and contraction, may in general be preferable to steel, this is by no means certain, since trouble with the lead lining at Sacramento developed in a manner almost identical with that at Montebello, both as to the time and the nature of the failures.

As at Montebello, the Sacramento tanks were originally lined with chemical lead weighing 10 lb per sq ft, and the joining of the lead plates along vertical seams was accomplished in a similar manner. No serious trouble was experienced for two or three years, after which it became necessary to reline the tanks. Heavier lead sheets were used in this replacement work, and the tanks now operate satisfactorily. An additional digestion tank has since been installed, with simplified details and supports.

Mr. Armstrong's experience with the corrosion of interconnecting piping and main feed lines closely parallels the difficulties previously experienced at the Sacramento plant. I recall the hectic days and nights that followed the unexpected and frequent failure of the piping during the initial period of operation of the alum sirup coagulation system. Conditions were aggravated in pipe fittings and specials, which are apparently distinctly less resistant to corrosion than is the pipe itself. Cast iron pipe was found to be, and is still considered, sufficiently resistant to the dilute solutions of alum, without lining. From my experiences in the conveyance of alum sirup and alum solutions, in different kinds of pipe, it appears that for lines up to 2 in. in diameter, chemical lead or 3- or 4-ply rubber water hose should be used. It is probably not necessary to employ the more expensive chemical hose. So far as valves for the lines are concerned, "Duriron" plug cocks have been found satisfactory in essential respects. For the construction of pipes 3 in. in size and above, in which dilute solutions are to be conveyed, high-grade cast iron is satisfactory, but pipes should not be used for alum sirup unless they are lead lined. Outside dosing lines of 3-in. cast-iron pipe with bolted joints of the universal type, have proved quite satisfactory after eight years of service.

Making up a $2^1/_2$ per cent stock solution as soon as the boiling stage of the process has been reached has advantages in point of ease of conveying the liquid and in freedom from troubles with proportional-feed apparatus. As Mr. Armstrong states, this appears to be an advantage that designers have not hitherto availed themselves of. On the other hand, arguments are not lacking in favor of the production of an alum sirup as the final stage of manufacture, if the experience at Sacramento may be taken as a criterion. For some eight years now, the concentrated solution, containing 33,000 grains of 17 per cent alum per gallon, has been successfully handled directly out of the digestion tanks and applied to the raw-water supply through semi-automatic proportional-feed equipment. In this instance the use of a motor-driven lead dipper wheel and lead lined ejectors solved the problem completely and involved, incidentally, the use of very simple and compact equipment.

HARRY N. JENKS, M. Am. Soc. C.E.
Visiting Professor of Hydraulic and Sanitary Engineering, University of North Carolina

Chapel Hill, N.C.
March 24, 1933

Economy in Increasing Vehicle Speed

DEAR SIR: The paper entitled "Cost of Traffic Delays," by S. Johannesson, in the March issue, is convincing and shows a sound method of determining the justifiable expenditures for highway improvements to eliminate the causes of traffic delays. In the case of delays caused by intersections, drawbridges, and the like, the problem presented to the highway engineer is more or less clean-cut. But there are other causes for delays which, as an economic problem, concern legislative bodies and traffic enforcement agencies as well as the engineer.

There is great economic loss in traffic delays caused by slow-moving vehicles on the highways. Mr. Johannesson has ably indicated a measure of the cost of traffic delays, but before the engineer is called upon to determine the economic justification of widening a highway to provide more lanes of travel, might it not be well to consider the economy of making some effort to speed up the slow-moving vehicles?

When a two-lane road, for example, becomes congested, it will be observed that the speed of all vehicles using the road, approaches that of the slowest vehicle, because the faster vehicles are unable to pass the slower ones. The economic loss becomes so great that the highway engineer has no difficulty in showing ample justification for providing one or more additional lanes of travel. An analysis of the traffic will, however, usually show that if less than 5 per cent of the vehicles could travel at a faster speed, there would be no congestion and hence no need for extra lanes of travel. In other words, the expense of widening highways is made necessary by a comparatively few vehicles.

It has been shown by A. N. Johnson, M. Am. Soc. C.E., that while the practical capacity of a two-lane highway is only 1,000 vehicles per hour, that of a four-lane road is 3,000. The only reasonable explanation for such a wide difference is that the additional lanes permit the removal of slow-moving vehicles from the lanes where the faster vehicles travel.

Thus far, only a few states have taken steps to speed up highway traffic, but it is evident from Mr. Johannesson's analyses of costs that this is a field that offers great possibilities for highway economies.

W. S. DOWNS, M. Am. Soc. C.E.
Consulting Engineer

Morgantown, W.Va.
March 9, 1933

SOCIETY AFFAIRS

Official and Semi-Official

Chicago Host to Sixty-Third Annual Convention

Plans for the Sixty-Third Annual Convention of the Society, to be held in Chicago during the last week in June, which has been designated as Engineers' Week of the Century of Progress Exposition, are almost perfected. Particularly favorable rail rates, in effect for all parts of the country during the Century of Progress Exposition, are expected to be a factor toward large attendance at the Society's Convention. Although actual information on rates should be obtained from local railroad ticket agents, a special sixteen-day round-trip rate from points on the Pacific Coast, amounting to one fare plus fifty cents, has been announced. Further details of railroad rates will be given in the formal program, which will appear in the June issue. Ample provision is also being made by the Century of Progress Exposition for the handling of private automobiles, so that no matter what means of transportation is selected the comfort of members is assured.

The headquarters for the Convention is to be the Palmer House, and all the meetings will be held there. The opening session of the Convention will be called to order at 10:00 a.m., on Tuesday, June 27, by W. W. DeBerard, M. Am. Soc. C.E., president of the Illinois Section. After the usual addresses of welcome, A. J. Hammond will deliver the President's Annual Address.

Tuesday afternoon will be devoted to a round-table conference on a subject of present interest to everyone, that is, the problem of tax reduction in municipal and state governments. This will be arranged by the Engineering-Economics and Finance Division. In the evening the American Association for the Advancement of Science is to have charge of the program, which will be open to the fourteen or more engineering societies that will be convened in Chicago during Engineers' Week. The feature of the occasion will be addresses on the industrial developments that have taken place during the past century.

No special sessions are scheduled for Wednesday, June 28, which has been designated Engineers' Day at the Century of Progress Exposition, and the entire day has been set aside for visits to the fair grounds and exhibits. There will be so much to see that many members will doubtless wish to give even more time to it after the Convention closes on Friday afternoon. In addition, it will be possible to devote evenings for the remainder of the Convention to the fair. Special arrangements are being made for a boat trip on Lake Michigan on Thursday evening. This will give an unparalleled opportunity to view the lighting effects of the Exposition, which are expected to be among its outstanding features.

Technical Divisions Meet

On Thursday the sessions of the Technical Divisions begin. In the morning the Power Division is to meet in joint session with the hydraulics division of the American Society of Mechanical Engineers. Among the scheduled subjects is a résumé of the reports on the St. Lawrence Power Development, to be presented by Daniel W. Mead, Hon. M. Am. Soc. C.E. The Structural Division is to combine both its morning and afternoon sessions with those of the applied mechanics division of the American Society of Mechanical Engineers for the presentation of papers on problems of stability and experimental research in structures. An interesting program is also being arranged by the Waterways Division. An extensive symposium on "A Century of Progress in Construction Methods" will be given by the Construction Division in two sessions, occupying both the morning and the afternoon. Each of the various phases of progress during the last hundred years will be presented in a brief but forceful report by recognized experts. These will include Anson Marston, Past-President Am. Soc. C.E., and O. H. Ammann, Elwood Mead, and Lytle Brown, Members Am. Soc. C.E. Programs for the afternoon sessions of both the Highway and the Surveying and Mapping Divisions promise also to be unusually stimulating.

On Friday the sessions of the Technical Divisions will again be the focal points of interest. The Power Division will continue in joint session with the hydraulics division of the American Society of Mechanical Engineers in an all-day symposium on the important subject of water hammer in pipe lines. This symposium will include a paper on the design of the Hoover Dam penstocks and pressure conduits. Again, on Friday, the Structural Division will join with the applied mechanics division of the American Society of Mechanical Engineers to consider problems of dynamics, such as bridge impact, locomotive nosing, and vibration amplitudes. These features will be considered at the morning session, and the afternoon will be devoted to the subject of suspension bridges, including an analysis of continuous spans. Interesting and timely programs have been arranged by the Sanitary Engineering Division, the Surveying and Mapping Division, and the City Planning Division for their Friday sessions.

With this wealth of technical material for presentation and discussion, there will be plenty to occupy the full attention of members seeking the latest developments in particular fields. The Convention presents a unique opportunity to combine professional advancement with sight-seeing in Chicago and at the Exposition. The various committees on arrangements have planned a worthwhile program for which they deserve due credit.

In the June issue there will be found a detailed program of the speakers, with subjects, dates, and time. It will also contain the best available information on hotel and railroad rates. Railroad ticket agents will have the latest data on routes and rates to Chicago. Members should consult their local agents if they desire to plan their trip before the early part of June.

New Memoirs Available

From time to time groups of memoirs of deceased members of the Society are published and their publication is announced in Civil Engineering. In addition to the considerable number that have already been prepared, the Society now has ready for distribution memoirs of the following:

Ernest Robinson Ackerman
John Joseph Albright
Henry Clayton Allen
Herbert Leander Aulls
Francis Wheelwright Belknap
Louis David Blauvelt
Willard Lewis Bowker
James McCormick Brockway
Frank Taylor Chambers
Winfield Walker Conard
Alger Adams Conger
Arthur Lincoln Davis
Paul Didier
Robert Lee Faris
John Moyer Farley
John Ripley Freeman
Walter Hamer Gahagan
Harrison Washburn Hayward
Arthur Rasco Hirst
Charles Warren Hunt
Charles William Irons
Jeremiah Joseph Kennedy
Thomas Monahan Lavelle
Henry Robertson Lordly
Carl Arthur McClain
John Alexander McLean
William Selby Mitchell
Robert Clayton Morris
William Barclay Parsons
Samuel Henry Pitcher
George Addison Posey
Samuel Moreau Purdy
Frederick George Ray
Frederick Jarrett Reinke
Carl Jonas Rhodin
Albert Henry Ross
Theodore Nelson Spencer
Vernon Christopher Suckow
George Fillmore Swain
William Wolcott Tefft
Joseph Edward Tempest
Otto von Goldern
Frank Herman Winterer
George Monroe Wisner
Herbert Waldo York
Morris Alexander Zook

Under the plan now in force, memoirs are published from time to time in groups, as separates, and then appear annually in Transactions. Those here listed have now been put in print so that copies of them may be obtained on application to Headquarters. The many requests that are received for such memoirs testify to their usefulness and to the appreciation with which they are regarded by friends and families of the deceased.

A Preview of Proceedings

As usual, no issues of PROCEEDINGS *will appear in June or July, so that the May number, to be placed in the mail on May 15, will be the last prior to the summer interval of suspended publication. Publication will be resumed with the August number, mailed on August 15. Three main papers will appear in the May issue.*

DEFLECTIONS AND TEMPERATURES IN ARIEL ARCH DAM

DURING the past few years the construction of arch dams, both of the pure arch type and of the arched gravity type, has increased considerably. This has been due partly to the need for economy in the cost of large structures and partly to the greater confidence that engineers have come to feel in this type of structure.

This greater confidence is the result of the good record of existing arches and of the considerable study that has been given to the theory of arch design, supplemented by tests on models and on the full-sized Stephenson Creek arch dam, built for that purpose. The "trial load" method of arch dam design has now come to be looked upon as giving a reasonably accurate picture of the stresses in such a dam and of the deflections to be expected in it. The paper by A. T. Larned and W. S. Merrill, Members Am. Soc. C.E., describing the design and construction of the 313-ft Ariel arch dam, on the Lewis River, Washington, gives a record of the deflections of that large structure from the time it was closed in May 1930 to March 1, 1932. These deflections show remarkably close agreement with the deflections computed during the design of the arch.

A record is given also of the temperature of the concrete in many parts of the arch, from the time it was placed up to March 1, 1932. This record was made from the readings of about 250 resistance-type thermometers buried in the concrete. Due to the rapid construction of the arch, it was built in blocks with 2-ft slots between, and several of the blocks were artificially cooled with circulating water. The records of concrete temperature, artificial cooling, and actual deflections secured at this important arch dam should be of great benefit in future design. They not only provide actual data on several phases of design but tend further to confirm the opinion that the "trial load" method of analysis is the best that has yet been evolved for the design of this important type of structure.

WIND STRESSES BY SLOPE-DEFLECTION AND CONVERGING APPROXIMATIONS

FEW SUBJECTS in recent years have claimed the amount of attention among engineers that has been accorded the effect of wind on buildings and their desirable structural analyses. Much credit for these advances should be given to the Structural Division's Committee on Wind Bracing in Steel Buildings. The paper on wind stress analysis by converging approximations, by John E. Goldberg, Jun. Am. Soc. C.E., in the May PROCEEDINGS, is supplementary, rather than opposed, to the work that has been carried on by this committee.

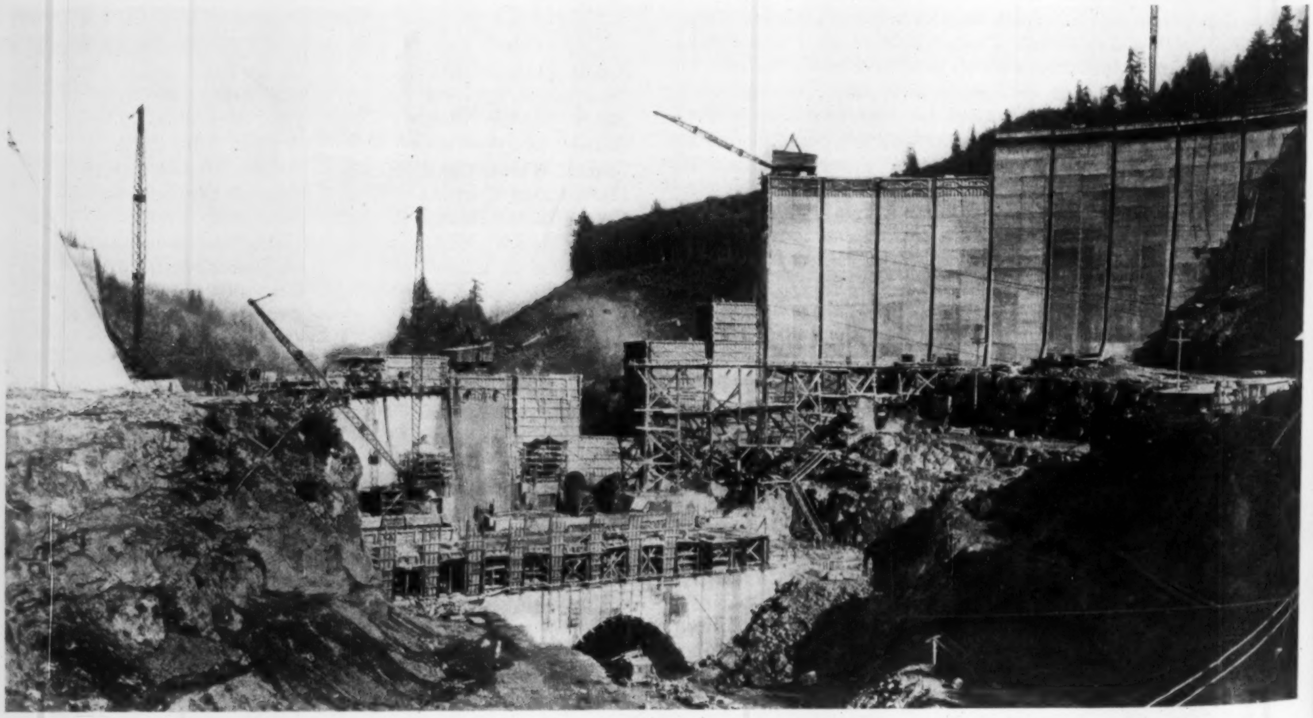
The new methods presented are based on the well known slope-deflection equations, long recognized as giving accurate results in the analysis of structural frames. Thus, Mr. Goldberg has taken an accepted basic principle on which to build methods of solution that greatly simplify the otherwise tedious computations. His method is to estimate one group of unknowns in a series of simultaneous equations and from these to find other unknowns with greater accuracy.

This method, while not new in itself, is shown to be a useful tool for computing wind stresses. It effects a workable, rapid, and accurate solution, illustrated in the paper by numerical example, not only for single bents but also for complete buildings. This latter analysis is effected by means of Mr. Goldberg's new conception, that of a "composite bent," a structural unit considered to take the place of a series of independent bents. As another feature, he presents a method for the analysis of the secondary wind stresses caused by column strains.

The paper builds on fundamental slope-deflection relations to develop a method of attack, as distinct from the basic principle. This method has the essential characteristic of workability, but not at the expense of accuracy. Discussion may be depended upon to determine the scope and applicability of these unique ideas.

PROGRESS REPORT OF COMMITTEE ON EARTHS AND FOUNDATIONS

IN PROCEEDINGS for May the Society's Committee on Earths and Foundations presents a progress report of considerable importance to all branches of civil engineering. It is based on two years of research work, conducted mainly at the Massachusetts



ARIEL ARCH DAM UNDER CONSTRUCTION ON THE LEWIS RIVER, WASHINGTON
Showing Construction Slots Between the Blocks of the Dam, and the Arch Supporting the Power House Over the Deeply Eroded and Silt-Filled River Channel

Institute of Technology under the direction of Glennon Gilboy, Jun. Am. Soc. C.E.; at the Technische Hochschule, Vienna, under Charles Terzaghi, M. Am. Soc. C.E.; at Columbia University; and at Yale University. The funds for this work were contributed by the Society and by The Engineering Foundation.

The report makes available the latest theories of soil mechanics, methods of obtaining soil samples, and laboratory procedure, so that the general problem of predicting the settlements of a large building erected on saturated deposits of fine material can be solved. To this end the distribution of pressures below loaded footings is defined according to the Boussinesq theory and developed so that iso-pressure lines, or lines of equal vertical pressure, can be readily computed and plotted. The rates of settlement are then calculated on the basis of the theories developed by Professors Terzaghi and Gilboy. In conjunction with the procedure for obtaining undisturbed soil samples, the committee had laboratory tests made to determine the necessary constants. As a check on theory and practice, a comparison was made between the observed settlements of a large structure erected on about one hundred feet of saturated clay and other materials, and settlements that were computed. These computations checked quite closely as to rate as well as amount.

Results of tests on flexible steel tanks erected on compressible material are reported, and the observed settlements of various buildings, in Europe and elsewhere, are described. Some interesting photo-elastic tests made at Columbia University to visualize the pressure below footings, serve to complete this highly meritorious piece of work.

Valuable Papers Filed for Reference

During the past few years a number of papers have accumulated in the files of the Committee on Publications, which for one reason or another it has not been feasible to publish, although they are considered to contain much of real value to the profession. Accordingly, at the request of the committee, the authors have kindly given their permission for the Society to file these papers for reference and in most cases have supplied brief résumés of their contents.

Some of these résumés are given herewith; others will be published from time to time. Originals of the papers here listed will be filed in the Engineering Societies Library where they will be indexed and may be consulted by any one interested. If photostats of them are desired, an estimate of the cost of such reproduction may be obtained direct from the Engineering Societies Library, 29 West 39th Street, New York, N.Y.

J. H. **Fitzgerald**, Assoc. M. Am. Soc. C.E., "Development of Pneumatic Concrete Placing" (6,000 words). The paper covers a brief description of pneumatic concrete placing as actually used on a few large jobs. Data are given with respect to the amount of compressed air required, size of aggregate pipe, and the distance that the concrete can be conveyed with economy.

Charles W. **Sherman**, M. Am. Soc. C.E., "Ground-Water Supplies from the Dunes of Holland" (text 2,000 words, including bibliography). The water supply engineers of Holland, faced with the necessity of developing all available resources of fresh water and aware of the danger of ruining well water supplies obtained from sand near the ocean, have made very extended theoretical and practical studies. Assuming the sand to be uniform, and knowing the slope corresponding to the rate of horizontal movement through the sand, the elevation of ground water can be computed, and from it the corresponding depth to salt water. After the effect of reducing the slope of the water table by removing fresh water at a given rate has been found, the corresponding height to which salt water will rise can be computed. Computations for test wells in North Holland gave results corresponding closely to the depth of the middle of the zone of brackish water in the wells.

Francis B. **Marsh**, M. Am. Soc. C.E., "The Scituate Water Supply of Providence, R.I." (about 11,000 words including tables; also about 30 illustrations). This paper describes the design and construction of works costing $20,000,000, completed in 1928, including an earth dam, rapid filters, large open coagulation basins, aerators, a $7^{1}/_{2}$-ft aqueduct, steel pipes, lock-joint pipes, and reinforced concrete covered distribution reservoirs. Unpublished details are given, as well as references to earlier papers.

When Writing to "Civil Engineering"

When writing to Civil Engineering, the letter should be addressed to Society Headquarters in New York and not to the publication offices in Easton, Pa. Many correspondents make this error and thus lose a day and sometimes more in the delivery of their letters.

The address of the publication offices in Easton, Pa., is required to satisfy postal regulations. This address, however, applies only to the letters intended for the company that does the actual printing, binding, and mailing of the various issues. As far as the editorial and advertising contents of Civil Engineering are concerned, the printer looks solely to headquarters for his instructions. Hence any inquiry, whether it concerns the actual printing or the editing, must first go through the editorial and advertising offices.

For any mail, therefore, that deals with Civil Engineering, to whatever phase of the work it applies, the safe procedure is to send it direct to Headquarters, at 33 West 39th Street, New York, N.Y. This will ensure the quickest delivery and correspondingly prompt attention.

Aiding Foreign Members

Although "American" in name, and primarily also in character and activities, the Society nevertheless is international in its scope. This is evidenced by the fact that approximately 800 members, or about 6 per cent of the total number, reside outside the United States.

Many of these members have been seriously embarrassed during recent months by the hardship of paying Society dues on account of the severely depreciated currency in other lands To have supplied the American equivalent of standard dues would have imposed an unfortunate burden.

Recognizing this fact and the value of these memberships, the Board of Direction has offered the Society's assistance by dividing with the members the excess due to unfavorable exchange from foreign currency. Thus both the member and the Society share the extra burden equally. The actual money value of this allowance to those members living in other countries is practically $2,000. This sum represents one aspect of the contribution of the Society to international economic amity.

News of Local Sections

COLORADO SECTION

The Colorado Section has elected officers for 1933 as follows: Lyman F. Copeland, President; and R. J. Tipton, Secretary-Treasurer.

DAYTON SECTION

A meeting of the Dayton Section was held at the Dayton Engineers Club on March 20, with 20 in attendance. After various business matters were attended to, Howard S. Smith, patent attorney and president of the Dayton Research Association, was introduced as the guest speaker. He gave an interesting talk on patents, copyrights, and trade-marks.

SIXTY-THIRD ANNUAL CONVENTION, June 27–30, 1933, During Engineers' Week, Century of Progress, Chicago

GEORGIA SECTION

On April 3 the Georgia Section, in conjunction with local sections of the American Society of Mechanical Engineers and the American Institute of Electrical Engineers, and the Georgia School of Technology Student Chapter, held a meeting at the Atlanta Athletic Club. There were 125 in attendance. The speaker of the evening was J. H. Persons, of the General Electric Company, whose subject was "Searching Into the Unknown and the Electric Eye."

ITHACA SECTION

There were 44 members and guests present at a dinner meeting of the Ithaca Section, held at the Langwell Hotel in Elmira, N.Y., on March 21. This was the largest attendance that the Section has had since its organization. The guest of honor was George T. Seabury, Secretary of the Society, who addressed the Section on recent Society activities. His talk was followed by a very interesting round-table discussion.

MARYLAND SECTION

On March 10, the Maryland Section held a joint meeting with the Baltimore section of the American Institute of Electrical Engineers, at the Johns Hopkins University. The principal speaker was Dr. T. S. Cullen, of the Johns Hopkins Hospital, who spoke on the advances made in surgery as a result of such inventions as the audiphone. A number of moving pictures were shown, illustrating the artificial larynx, the audiphone, and the modern Bell telephone.

METROPOLITAN SECTION

At the regular monthly meeting of the Metropolitan Section held in New York, N.Y., on April 10, a committee to nominate officers for the Section for the ensuing year was elected as follows: J. F. Sanborn, A. S. Tuttle, H. M. Lewis, R. Ridgway, and L. G. Holleran. After announcements and a report of the social welfare committee of the Professional Engineers Committee on Unemployment, the subject of "Recent Engineering Advancement in Aviation" was presented by Stephen J. Zand, Aeronautical Research Engineer for the Sperry Gyroscope Company. He described many of the devices used to make transportation by air safe and comfortable, including achievements in "blind flying" and soundproofing. Motion pictures illustrated several of the features. Immediately following this, the final contest in the annual Effective Speaking Contest for members of the Junior Branch was held. As a result, prizes were awarded to the following Juniors: Clare M. Leonard, first prize; Charles W. E. Schroeder, second prize; and Samuel C. Clark and John J. Knox, honorable mention. Refreshments were then served. The attendance was about 325.

NEBRASKA SECTION

The Nebraska Section cooperated in the Nebraska Engineers' Round-up, which was held in Omaha on February 25. Among the speakers were Dr. W. M. Barr, Assistant to the Executive Vice-President of the Union Pacific System, who spoke on "The Hoover Dam"; and Richard V. Murison, an architect of Chicago, Ill., who discussed "The Century of Progress Exposition." All sessions were well attended, and there were 250 present at the evening entertainment, one of the features of which was an interesting electrical demonstration.

NORTH CAROLINA SECTION

On February 9, the North Carolina Section elected the following officers for 1933: C. L. Mann, President; W. C. Olsen and J. L. Becton, Vice-Presidents; and Harold C. Bird, Secretary-Treasurer.

NORTHEASTERN SECTION

Officers for the Northeastern Section for 1933 have been elected as follows: Arthur D. Weston, President; and Harry P. Burden, Secretary.

NORTHWESTERN SECTION

A dinner meeting of the Northwestern Section was held jointly with the University of Minnesota Student Chapter at the Minnesota Union Building of the university on March 3. The principal speaker was James R. Stack, who has recently been employed as director of construction for the Arthur G. McKee Company, of Cleveland, Ohio, on a large steel plant at Magnitogorsk, Russia. The subject of his talk was "Engineering Experiences in Russia." Slides and photographs of the activities of the civil engineering department at the university's summer camp were then shown by members of the Student Chapter. There were 56 present at the meeting.

OKLAHOMA SECTION

The officers of the Oklahoma Section for 1933 are as follows: E. S. Alderman, President; and E. R. Stapley, Secretary-Treasurer.

PHILADELPHIA SECTION

On March 16 the Philadelphia Section held a dinner meeting, with 47 in attendance at the dinner and 110 at the meeting. The first speaker was N. E. Funk, Vice-President of the Philadelphia Electric Company, who gave an interesting illustrated lecture on electric power conditions and distribution in the Philadelphia district. Others who spoke were: Norman Litchfield, Engineering Director for Gibbs and Hill, whose subject was "Development of Design of Railroad Electrification Catenary Structure"; G. I. Wright, Chief Electric Engineer of the Reading Company, who spoke on "Catenary Construction"; and H. C. Griffith, Assistant Electrical Engineer of the Pennsylvania Railroad Company, whose subject was "Power Dispatching." After the meeting refreshments were served.

Appointments of Society Representatives

OLE SINGSTAD, M. Am. Soc. C.E., has been appointed to represent the Society on the Division of Engineering and Industrial Research of the National Research Council for the term, June 1933–June 1936.

SAMUEL A. GREELEY, M. Am. Soc. C.E., has accepted an appointment to serve as a Society representative on the Washington Award for the two-year term, June 1933–June 1935.

American Engineering Council

National representative of 26 engineering societies, with a constituent membership of 60,000 professional engineers, reports civil engineering news of the Federal Government

FEDERAL MEASURES TO AID BUSINESS RECOVERY

As the Administration's program for aiding business recovery and relieving unemployment now takes shape, three definite phases are discernible: (1) an interim employment plan to provide immediate unemployment relief; (2) direct relief of destitution with Federal funds; (3) an extensive nation-wide employment program of large-scale proportions, which will doubtless include public works projects and other activities of interest to engineers.

The first phase of the program is already in operation. With the approval, on March 31, of Senate Bill 598, an act for the relief of unemployment through the performance of useful public works and for other purposes, the President is authorized to provide for employment of unemployed U.S. citizens: (1) in construction, maintenance, and carrying on of works of a public nature in connection with forestation of United States or state lands suitable for timber production; (2) in prevention of forest fires, floods, soil erosion, and control of plant pests and disease; and (3) in construction, maintenance, or repair of paths, trails, and fire lanes in National Parks and Forests.

The President has been authorized to provide for housing, subsistence, clothing, medical attendance, hospitalization, transportation, and cash allowance for the men so employed. In the exercise of this authority the President is utilizing the administrative facilities of existing Federal agencies. Recruiting of the unemployed is under the auspices of the Department of Labor. The men selected are being trained and conditioned by the U.S. Army. The administration of the work projects is being handled by the Forest Service of the Department of Agriculture.

It is thought unlikely that this program will have any particular significance as regards the employment of engineers for the performance of professional services. It is of course quite possible that members of the profession in straitened circumstances will elect to enroll in the labor groups being organized to perform this work.

Of more particular interest to the profession and to the construction industry is the method of financing this program. The act authorizes the expenditure, with certain exceptions, under the direction of the President, out of unobligated moneys already appropriated for public works, of such sums as may be necessary. Of the $149,000,000 of such funds now unobligated, nearly $78,000,000 represents sums already appropriated for the construction of Federal buildings by the office of the Supervising Architect. An additional $50,000,000 represents former flood-control and river and harbor appropriations. It is estimated that $40,000,000 will be expended in the reforestation program prior to the end of the fiscal year, July 1, 1933.

The second phase of the integrated Administration program deals with relief of destitution by direct Government contribution, and marks a distinct change from former policy. Senate Bill 812 received the approval of the Senate on March 30, and early enactment is expected. It provides for the establishment of a Federal Emergency Relief Administration under the control of an Administrator, in whom is vested complete control of the expenditure of Federal funds, amounting to $500,000,000, for relief purposes. The bill transfers to the proposed Administration the duties formerly executed in this connection by the Board of Directors of the Reconstruction Finance Corporation.

The Administrator is authorized to make direct grants to the several states to aid in meeting the costs of furnishing relief and work relief, services, materials, and commodities, to provide for the necessities of life to persons in need as a result of the present emergency. Of the total amount available, $200,000,000 is to be granted to those states making application in accordance with a definite procedure which requires the expenditure by the state of an additional amount equal to twice the Federal grant. The remainder is to be used at the discretion of the Administrator for grants to states where this provision fails to meet the necessities of the situation. The Administrator is also authorized to use these funds to aid in assisting cooperative and self-help associations for the barter of goods and services.

The provisions for the expenditure of this money on work relief projects and for the assistance of cooperative and self-help associations have a definite bearing on the unemployment situation among engineers. It is likely that work relief projects and other plans of unemployment relief which have been devised by the several engineering committees in the larger cities will be greatly assisted on the enactment of this legislation.

The third and most important phase of the program outlined is still in the formative stage. No definite announcement has been made by the Administration but it is expected that public works will occupy a prominent place in the perfected plan. Concerted efforts are now being made by the American Engineering Council, the American Society of Civil Engineers, and others, to provide appropriations for an extensive participation of the Federal Government in topographic surveys and stream gaging. These activities, administered by the Coast and Geodetic Survey and the Geological Survey, will provide employment for several thousand engineers if funds are made available. The members of the engineering profession can render a distinct service to those of their members who are unemployed by calling to the attention of their Representatives in Congress the desirability of including these types of work in a relief program.

Tennessee River Project

A joint resolution, S. J. Res. 4, introduced by Senator Norris on March 9, provides for improving navigability and for controlling floods of the Tennessee River; for reforestation and the proper use of marginal lands in the Tennessee Valley; for agricultural and industrial development of that valley; and for the national defense through the creation of a corporation for the operation of Government properties at and near Muscle Shoals, and for other purposes. The resolution provides for the establishment of the Muscle Shoals Corporation of the United States, with authority to manufacture fixed nitrogen and to engage in the production of power through the use of the Government's generating facilities at Muscle Shoals. It authorizes the corporation to sell and distribute surplus power to states, counties, municipalities, corporations, partnerships, or individuals. It also authorizes the Secretary of War to construct the Cove Creek Dam for the purpose of regulating the flow of the Clinch and Tennessee rivers, so as to increase the amount of primary power that may be developed at Wilson Dam. Bills similar to the Norris resolution have been introduced in the House.

Legislation for Shorter Working Hours

Bills providing for the enforcement of a 30-hr week in the production of goods to be transported in interstate commerce have been reintroduced in both Houses. The Black Bill, S. 158, received the approval of the Senate on April 6. This bill is substantially the same as that introduced in the last session of the 72d Congress, but as passed by the Senate it includes amendments exempting certain industries engaged in the production of perishable goods.

Effort to Amend Emergency Relief and Construction Act of 1932

Senator Wagner has reintroduced his measure designed to amend the Emergency Relief and Construction Act of 1932. Inasmuch as the relief measures of this act are expected to be taken care of in bill S. 812, already described, the new bill, S. 509, is limited only to that section of the act dealing with loans for construction projects and agricultural marketing. The bill provides for liberalizing the restrictions governing loans for construction purposes in accordance with recommendations previously submitted by the engineering profession and construction industry. The essential changes proposed are: (1) eliminating the self-liquidating clause in connection with loans to governmental bodies and substituting the requirement that such projects shall be needful and in the public interest; (2) enlarging the scope of projects for which loans can be made to private corporations so as to include urban water systems and irrigation systems; (3) removing the requirement that interest payment and amortization of loans to governmental bodies must be by means other than taxation; and (4) providing that loans for housing projects can be made for a period in excess of ten years. The proposed changes are in substantial accord with the recommendations of the Board of Direction of the Society, adopted by the Council last January, and the Council is actively supporting this legislation.

Other Pending Legislation

Other pending bills of interest to engineers are:

S. 249, which provides for the construction of works for the development of the Columbia River and minor tributaries.

H R. 81, to regulate the construction of bridges over navigable waters and to revise the laws pertaining to them.

S. 808, to amend the Federal Water Power Act, as amended.

Flood control bills, to provide examination of certain rivers in the State of Washington: H.R. 3353, for the Stillaguamish River; H.R. 3354, for the Snohomish River; H.R. 3362, for the Nooksack River; and H.R. 3363, for the Skagit River.

H.R. 3204 would provide for the New York Bay Bridge connecting Brooklyn and Staten Island.

H.R. 3371 would revive and re-enact an act for the construction of a bridge across the Potomac River at or near Great Falls.

Certain irrigation bills are also pending: S. 602, for the storage for diversion of the waters of the North Platte River and construction of Saratoga reclamation project; H.R. 3205, for construction of a drainage channel in a closed basin of San Luis Valley in Colorado, and authorizing an investigation of reservoir sites; H.R. 3222, authorizing loans by the Reconstruction Finance Corporation to aid in refinancing obligations of drainage districts; and H.R. 3901, authorizing the Reconstruction Finance Corporation to make advances to the reclamation fund.

Power Commission Authority Clarified

The action of the Appalachian Electric Power Company to enjoin the Federal Power Commission from interfering with the company's project on the New River in Virginia was dismissed on March 30 in the U.S. District Court for the Western District of Virginia. In an opinion by Judge Luther B. Way, the court sustained the power of the commission over hydro-electric plants on non-navigable streams under certain conditions.

ITEMS OF INTEREST

Engineering Events in Brief

Civil Engineering for June

FIFTY YEARS AGO, on May 24, 1883, Brooklyn Bridge, New York, was opened to the public. Its construction involved the solving of the greatest engineering problems faced up to that time. Before the bridge was built, the only means of crossing the East River was by ferry; now tunnels and several other bridges carry the traffic, but in conception and construction features, Brooklyn Bridge remains a romantic chapter in the history of American bridge construction. It is appropriate that the June number of CIVIL ENGINEERING should contain an article by Edward A. Byrne, M. Am. Soc. C.E., describing the difficulties encountered by the sponsors of the project in carrying it through to completion.

Spreading destruction, famine, and death over wide areas annually, the rivers of China present a flood control problem that has taxed the patience and ingenuity of the Chinese from earliest times. The China International Famine Relief Commission has been interested in this situation for years, and it is not surprising that one of their methods of relieving famine conditions takes the positive form of preventing the floods that cause famine. In an article on controlling some of China's vagrant rivers, to appear in the June issue, O. J. Todd, M. Am. Soc. C.E., Chief Engineer for the commission, emphasizes the fact that engineers, in planning construction work in China, must think in terms of the things available and remember the importance of human labor rather than of modern machinery. From a background of fourteen years of intimate contact with flood-control problems in China, he describes the methods used to divert the Yellow River back into its original channel, and other work.

Indicative of the great interest in inland waterway transportation in Europe is the history of the development of the Oder River in Germany. Since earliest times timber dams have been constructed on the Oder, not so much for the regulation or control of river flow as to prevent navigation between the feudal states along its course. Covered by a dense oak forest, the river valley in early times suffered frequent damage and destruction due to the erratic changes in the river's course. Straightening the alignment, reveting and protecting the banks with groins, canalizing, and augmenting the low flow from storage reservoirs have so improved the river that navigation on it is now heavy and profitable. The many difficulties overcome in solving the problem of taming the wild Oder River and converting it into a useful inland waterway are described by John B. Drisko, Jun. Am. Soc. C.E., in an article, "Improving the Oder River," to appear in the June issue.

When neither rainfall nor run-off records are available over a sufficient period of time for studying problems involving water power, irrigation, and kindred engineering projects, the engineer seeks other indices for determining the cyclic trends on which he must base his calculations. These indices have included tree rings, sun spots, clay varves, ocean temperatures, and crop records, and the proponents of each of these indices find remarkable agreement between predictions and the facts revealed by records. In an article, "Rainfall and Crops," scheduled for the June issue, Isaac Gutmann, Assoc. M. Am. Soc. C.E., submits examples of the undesirability of relying to any great degree upon crop yields as an index of rainfall for the same season. Too many other factors influence the maximum crop. The optimum crop often coincides with subnormal rainfall, and crops of different grains in the same locality do not give consistent yields. There is food for thought in this provocative article.

The subject of waves in channels carrying water is complex but fascinating, and of considerable importance to the designer of irrigation conduits. Whenever the steady flow of water in a channel is suddenly increased, an abrupt wave will travel down the channel. When the flow is suddenly decreased at the intake, a sloping wave will travel down the channel. In general, a change that acts to increase the depth, creates a wave with a vertical face; one that decreases the depth causes a wave with a sloping face. An article by Horace W. King, M. Am. Soc. C.E., explains these phenomena and derives formulas for the velocity of the wave.

Because of unforseeable circumstances, it has been necessary to postpone the publication of one of the articles announced for this May number. The article in question is that by Jasper H. Ings, Jun. Am. Soc. C.E., on the Temiscouata Dam in Quebec, Canada. Interested readers may now look forward to the appearance of this article in the June issue.

Centenary of Death of Richard Trevithick

RICHARD TREVITHICK, JR., was born in 1771 in the copper mining district of Cornwall, England, the son of a mine superintendent and engineer. He invented the high-pressure steam engine and made the first practical application of steam to propel vehicles on rails. To convince himself that power applied to a wheel would cause the wheel to roll rather than slip, he employed the simple expedient of unhitching the horses from his carriage on a hill and applying his own great strength to the spokes of one of the wheels. After building a number of road locomotives and operating them over the rough pavement of Oxford Street, London, Trevithick learned that a smooth road of iron was the best suited to the effective running of his steam horse.

From that time, about 1802, he devoted his thoughts and energies to the railway form of locomotive. In February 1804, near Merthyr Tydfil, Wales, he successfully operated a locomotive on the Basin tramroad. In describing the event in letters to a friend he wrote:

"The tram-waggon has been at work several times. It works exceedingly well and is much more manageable than horses. We have not tried to draw more than 10 tons at a time, but I doubt not

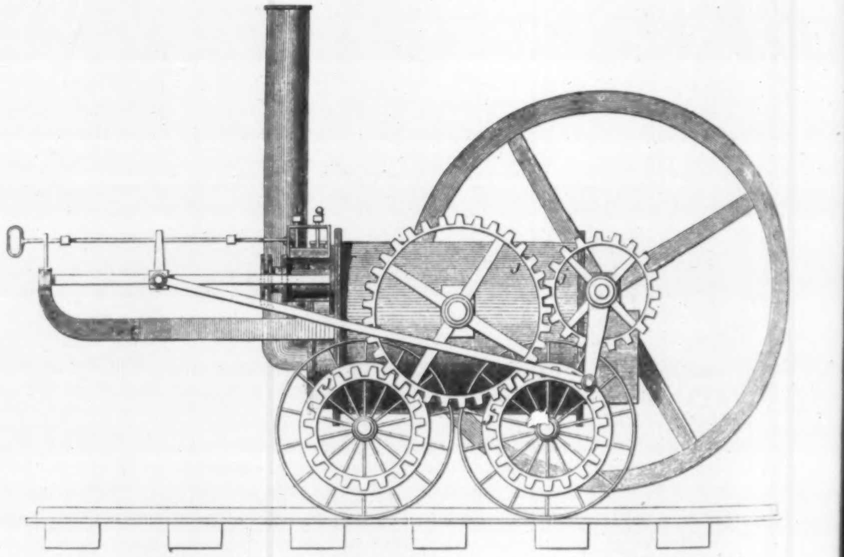


FIG. 1. TREVITHICK'S TRAMROAD LOCOMOTIVE, SOUTH WALES, 1803
Cylinder $8^1/_4$ In. in Diameter with a 4 Ft 6 In. Stroke; Cast-Iron Boiler; Weight in Running Order, 5 Tons

we could draw 40 tons at a time very well; 10 tons stand no chance at all with it. We have been but two miles on the road and back again.

. . . .

"The engine, with water included, is about 5 tons. It runs up the tramroad of 2 inches in a yard forty strokes per minute with the empty waggons. The engine moves forward 9 feet at every stroke.

. . . .

"The steam that is discharged from the engine is turned up the chimney about 3 feet above the fire, and when the engine works forty strokes per minute, $4^1/_2$-feet stroke, $8^1/_4$ inches diameter of cylinder, not the smallest particle of steam appears out of the top of the chimney, though it is but 8 feet above where the steam is delivered into it; neither at a distance from it is steam or water found. I think it is made a fixed air by the heat of the chimney. The fire burns much better when the steam goes up the chimney than when the engine is idle.

. . . .

"Yesterday we proceeded on our journey with the engine; we carried 10 tons of iron, five waggons, and seventy men riding on them the whole of the journey. It is above nine miles, which we performed in four hours and five minutes. We had to cut down some trees and remove some large rocks out of the road. The engine, while working, went nearly five miles per hour; no water was put into the boiler from the time we started until we arrived at our journey's end. The coal consumed was 2 cwt. On our return home, about four miles from the shipping-place of the iron, one of the small bolts that fastened the axle to the boiler broke, and all the water ran out of the boiler, which prevented the return of the engine until this evening."

Constant breakage of the cast-iron tram-plates under the loads of locomotive and trams caused the discontinuance of this operation.

Two features in locomotive design should be noted as being first applied by Trevithick, that is, exhausting the steam from the cylinders into the stack for increasing the draft and coupling the driving wheels together with a solid axle. In one of his earlier locomotives, in 1802, exhausting the steam into the stack caused the fire to become so hot as to be unmanageable. A part of the exhaust steam was diverted to heat the boiler feed-water.

About the same time, Boulton and Watt were working on the vacuum or low-pressure type of engine in which the pressures rarely exceeded 4 or 5 lb per sq in. They were so opposed to Trevithick's high-pressure steam designs—operating with steam pressures of 30 to 145 lb per sq in.—that they attempted to get an act of Parliament passed as a measure of public safety to prevent the construction of any more engines on the high-pressure principle.

Continuing his engine building, it was in 1808 that Trevithick not only constructed a new locomotive engine but a railway as well, so that the London public could see what a high-pressure steam engine could do on rails. The reproduction on the page of special interest of this issue is from a woodcut by W. J. Welch illustrating Trevithick's "Catch-me-who-can" in operation in London during that year. This locomotive had a single vertical cylinder with connecting rods attached to crank pins fastened to the spokes of but one pair of driving wheels. Having learned that the friction of one pair of wheels was enough to do the work, the elaborate geared wheels of the locomotive of 1803, shown in Fig. 1, were eliminated.

Trevithick's invention of the high-pressure steam engine made the railroad locomotive possible. He then diverted his inventive genius to other lines of endeavor, leaving the next development of the railroad locomotive to Stephenson, Hackworth, and others. The 100th anniversary of Trevithick's death, on April 22, 1833, was made the occasion by British engineering societies of a memorial to this engineering genius, now justly acclaimed as the Father of the Steam Locomotive.

[*Acknowledgment is made to "Life of Richard Trevithick, Inventor of the Locomotive Engine," by Francis Trevithick, published by E. and F. N. Spon, London, 1872, for the reproduction of the woodcuts by W. J. Welch, and for the historical data on which this sketch is based.*]

Safest Cities in 1932

Of the 442 entries in the First Annual National Traffic Safety Contest, sponsored by the National Safety Council, seven cities were designated as having made "the greatest progress during 1932 in traffic safety." The total population represented by these 442 entrants exceeded 30,000,000. All the cities were divided into classes according to size. The winner in each classification is given in the following tabulation:

Population Group	City
Over 500,000	Pittsburgh, Pa.
250,000 to 500,000	Rochester, N.Y.
100,000 to 250,000	Wichita, Kans.
50,000 to 100,000	Evanston, Ill.
25,000 to 50,000	Dubuque, Iowa
10,000 to 25,000	Norwood, Mass.
Under 10,000	La Grange Park, Ill.

Pittsburgh and Evanston were jointly awarded the grand prize for supreme achievement in advancing traffic safety.

The grading schedule, on the basis of 110 points for a perfect score, was as follows:

Accident reduction	50 points
Accident records and death-rate reduction	50 points
Accident reporting	5 points
Traffic engineering	10 points
Traffic law enforcement	15 points
Child safety	10 points
Public education	10 points
Community safety organization	10 points

This is the first national contest of the sort ever held. It is gratifying to note that in 1932 the fatalities from traffic accidents showed an annual decrease for the first time since the coming of the automobile. The contest has proved so valuable in causing cities to face their traffic problems squarely that a Second Annual Traffic Safety Contest is now under way. There is no entry change, and no obligation is incurred by the entering city other than the submission of monthly traffic records on standard forms. The National Safety Council, of which Sidney J. Williams, M. Am. Soc. C.E., is secretary, has its offices at 20 North Wacker Drive, Chicago, Ill.

Dr. Marx Resigns from R.F.C.

The Reconstruction Finance Corporation announces that it has accepted with regret the resignation of Charles D. Marx, Hon. M. Am. Soc. C.E., from the chairmanship of its Engineers' Advisory Board. Dr. Marx returns to Stanford University at Palo Alto, Calif., where he is Professor Emeritus of Engineering. No successor to the chairmanship of the Advisory Board has yet been named.

NEWS OF ENGINEERS

From Correspondence and Society Files

H. H. Ling has been made Director and Engineer-in-Chief of the Chuchow-Shaochow section of the Canton-Hankow Railway, with headquarters in Canton, China. He was formerly employed in a similar capacity on the Tungkwan-Sianfu section of the Lunghai Railway, at Chengchow.

Frank E. Waterman, formerly Commissioner of Public Works of Providence, R.I., has now become affiliated with the Waterman Engineering Company, also of Providence.

Harry Englander, who has been employed as an engineer with the Deutschbein Company, of New York, N.Y., has now accepted a position with A. Janin and Company, Ltd., Contractors and Builders, of Ville Lasalle, Quebec, Canada.

Charles R. Ege has been appointed Assistant Secretary of the Portland Cement Association, with offices in Chicago, Ill. He was formerly manager of the advertising and publications bureau of this association.

T. Harold Sanderson has accepted a position on the Engineers' Advisory Board of the Reconstruction Finance Corporation, in Washington, D.C. He was previously employed in the Division Engineer's Office of the Baltimore and Ohio Railroad, with headquarters in Chillicothe, Ohio.

William R. Wolff has entered the employ of the Public Service Commission of New York, N.Y., in the capacity of Assistant Engineer.

THOMAS G. TAYLOR has accepted a position as Assistant Engineer with the Portland Cement Association, with headquarters in Chicago, Ill.

JOHN J. MCNEELY has accepted a connection as Construction Engineer in the U.S. Treasury Department. His office is in the U.S. Custom House, in New York, N.Y.

PERCY ALLEN SEIBERT has accepted a position as general representative of the Braden Copper Company in Santiago, Chile. He was previously lawyer-assistant to the general representative in South America of Guggenheim Brothers, with offices in the same city.

M. N. QUADE, who formerly served as Designer for Waddell and Hardesty, of New York, N.Y., is now employed as Designing Engineer for Parsons, Klapp, Brinckerhoff, and Douglas of the same city.

HENRY KERCHER has been promoted from the position of Engineer to that of Vice-President and General Manager of the Broadway and Newport Bridge Company, Inc., of Newport, Ky.

JULIAN HINDS, formerly Chief Designing Engineer for the Metropolitan Water District of Southern California, has been advanced to the status of Assistant Chief Engineer of this organization. His headquarters will continue to be Los Angeles.

PAUL M. LABACH recently established a consulting engineering practice at 850 Lake Shore Drive, Chicago, Ill. Previously he was employed as an engineer in the Water Service Department of the Rock Island Lines, with offices in the same city.

NORMAN W. KELCH, for six years Secretary-Manager of the Clay Products Institute of California, has resigned to engage in the finance business at 3800 Weston Place, Long Beach, Calif.

E. L. MACDONALD, formerly Associate Engineer for Waddell and Hardesty, of New York, N.Y., has accepted a position in a similar capacity with Parsons, Klapp, Brinckerhoff, and Douglas of the same city.

J. HERMAN T. MCGEE has been appointed County Engineer of Collier County, Florida. He will retain his position as Office Engineer for the Barron G. Collier Interests, of Everglades, Fla.

ERNEST GRAHAM RICE has been made President and General Manager of the Monarch Pipe and Creosoting Company, of Tacoma, Wash.

Changes in Membership Grades

Additions, Transfers, Reinstatements, Deaths, and Resignations

From March 10 to April 7, 1933, Inclusive

ADDITIONS TO MEMBERSHIP

ALEXANDER, JAY (Assoc. M. '32), Civ. and Mech. Engr., 301 B Thomas Bldg., Dallas, Tex.

ALLEN, LLOYD LEE (Jun. '32), Philomath, Ore.

BROWN, RAYMOND SHEARER (Jun. '32), 42 Jefferson Ave., Sharon, Pa.

BRUNS, RICHARD PAYNE (Jun. '33), Junior Engr., U.S. Engr. Office, Huntington, W.Va.

BUCK, HORACE MILLER (Assoc. M. '33), 79 Milk St., Room 710, Boston, Mass.

COLLINS, CHESTER PAINE (Assoc. M. '33), Res. Engr., Los Angeles County Road Dept. (Res., 2366 Laverna Ave.), Los Angeles, Calif.

DAVIS, PAUL WESLEY (Assoc. M. '33), With the Wichert Continuous Bridge Corporation, 1620 Grant Bldg., Pittsburgh (Res., 734 Hill St., Wilkinsburg), Pa.

DEWEESE, OMER LYNN (Jun. '33), Chf. of Survey Party No. 4, State Highway Comm., 502 East Chandler Ave., Evansville, Ind.

FORBIS, JOHNSON LINVILLE (Jun. '33), Bridge Insp., State Highway Dept., 711 East Kirk St., Hugo, Okla.

GIARDINI, ANGELO JOHN MARSHALL (Jun. '32), Box 14, Deep River, Conn.

GILFILLAN, ROBERT ALEXANDER (Jun. '32), 3541 Bleigh St., Philadelphia, Pa.

GOLDMAN, PERRY JOSEPH (Jun. '33), Asst. Chf. Engr., Golder Constr. Co. (Res., 5323 West Berks St.), Philadelphia, Pa.

GRIFFIN, JAMES H. (M. '33), Engr.-in-Chg., Contract Div., Board of Transportation, 250 Hudson St., New York, N.Y.

GUSTAFSON, WILFRED FRANK (Jun. '32), 4802 Ave. H, R.F.D. 3, Austin, Tex.

HAAS, EDWARD THOMPSON (Jun. '33), Collector, Board of Transportation (Res., 21 West 51st St.), New York, N.Y.

HOWE, JOSEPH WARNER (Assoc. M. '33), Asst. Prof., Mechanics and Hydraulics, State Univ. of Iowa, 209 Eng. Bldg., Univ. of Iowa, Iowa City, Iowa.

HUGHES, HENRY CLAY (Assoc. M. '33), Asst. Engr., State Highway Dept., 1007 Nixon Bldg., Corpus Christi, Tex.

ISELEY, ALFRED HENRY (Assoc. M. '33), 1244 Maryland Ave., N.E., Washington, D.C.

JOHNSON, BARCLAY GIDDINGS (Jun. '32), 272 West 73d St., New York, N.Y.

JOHNSON, STANLEY LATHROP (Jun. '32), 24 Mohegan Rd., Ossining, N.Y.

KNOTH, FREDERICK CONRAD (Assoc. M. '32), 1249 3/8 North Fairfax Ave., Hollywood, Calif.

MACKEY, LINCOLN (Assoc. M. '32), Box 307, Rosslyn, Va.

MAIS, ERNEST NOEL (Assoc. M. '33), Engr., Mais & Sant, 10 Harbour St., Kingston, Jamaica.

MITCHELL, HENRY BAGLEY (Jun. '32), 4 Summit Ave., Winchester, Mass.

PACK, JOHN GEORGE, JR. (Jun. '32), 120 Woodland Ave., Bridgeport, Conn.

RANDLETT, CHARLES EDWIN (Jun. '32), Hanford, Calif.

RANKIN, TOM HARRISON (Assoc. M. '33), Asst. Chf. Engr., Triest Contr. Corporation, 395 Lexington Ave., New York (Res., 10 Bowne Ave., Flushing), N.Y.

ROGAN, JOHN EDWARD, JR. (Jun. '32), Rodman, 2d New Orleans Dist., U.S. River Comm., Baton Rouge (Res., 3303 Banks St., New Orleans), La.

ROLIN, RAYMOND GUSTAF (Jun. '33), Asst., Dept. of Civ. and San. Eng., Mass. Inst. Tech., Cambridge (Res., 10 Verona St., Lynn), Mass.

RUCQUOI, LÉON GUILLAUME (Assoc. M. '33), Executive Director, Ossature Metallique, 54, Rue des Colonies, Brussels, Belgium.

SÁNCHEZ, JUAN HERMINIO (Jun. '32), Box 231, Mayaguez, Puerto Rico.

SHANNAHAN, GEORGE DAVID (Jun. '32), Supt., Shannahan Brothers, Inc., 6181 Eastern Ave. (Res., 3891 South Hobart Boulevard), Los Angeles, Calif.

SPELLMAN, ROGER DRISCOLL (Assoc. M. '32), Structural Engr., Rust Eng. Co., Pittsburgh (Res., 329 Thomas St., Carnegie), Pa.

THOMSON, GORDON HOPE (Jun. '32), Ballinger, Tex.

TOTAL MEMBERSHIP AS OF APRIL 7, 1933

Members	5,802
Associate Members	6,323
Corporate Members	12,125
Honorary Members	18
Juniors	2,963
Affiliates	113
Fellows	5
Total	15,224

TIFFANY, JOSEPH BENJAMIN, JR. (Jun. '32), 416 North Frederick, Cape Girardeau, Mo.

WARD, RICHARD B. (Assoc. M. '33), Asst. Engr., Met. Water Dist. of Southern California, 1353 Western Ave., Glendale, Calif.

WARNER, FAYETTE SAMUEL (Assoc. M. '32), Valuation Engr., Edward J. Cheney, 61 Broadway, New York, (Res., 299 Beresford Rd., Rochester), N.Y.

MEMBERSHIP TRANSFERS

BARNARD, ARCHER FORTESCUE (Assoc. M. '15; M. '33), Cons. Engr. (Quinton, Code & Hill-Leeds & Barnard), Suite 712 Standard Oil Bldg., Los Angeles, Calif.

CLARKSON, EDWARD HALE, JR. (Assoc. M. '27; M. '32), Junior Civ. Engr., Bureau of Eng. Los Angeles (Res., 2009 Cheremoya Ave., Hollywood), Calif.

CRENSHAW, ALLEN EHLERS (Jun. '28; Assoc. M. '32), Civ. Engr., 542 Mason St., San Francisco, Calif.

EGNER, CARL ALEXANDER (Assoc. M. '20; M. '33), Hydrographic and Geodetic Engr., U.S. Coast & Geodetic Survey, Commanding Officer, Ship Natoma, Box 534, Ship Natoma, Norfolk, Va.

HEDGES, WARREN BARTLETT (Jun. '27; Assoc. M. '33), Treas. and Supt., Hedges-Weeks Constr. Co., 415 Holland Bldg. (Res., 937 North Jefferson Ave.), Springfield, Mo.

HOOD, HUGH KENDALL (Assoc. M. '10; M. '33), Senior Engr., Jensen, Bowen & Farrell and H. E. Riggs (Res., 216 South Ingalls St., Apartment 10), Ann Arbor, Mich.

MCGREW, EDWARD JOSEPHUS, JR. (Jun. '27; Assoc. M. '33), Engr., Swart-Brent Eng. Co., 52 Wall St., Room 1905, New York, N.Y.

PAFFRATH, ERNEST HERMAN (Assoc. M. '27; M. '33), Asst. Sewer Commr. of St. Louis (Res., 5348 Nottingham Ave.), St. Louis, Mo.

SADDAM, TOMAS ABRINA (Jun. '27; Assoc. M. '33), Asst. Hydr. Engr., U.S. Engr. Office, Federal Bldg., Rock Island, Ill.

RESIGNATIONS

ANDREWS, JOSEPH III, Assoc. M., resigned April 4, '33.

BROBERG, FREY LORENTS, Assoc. M., resigned March 20, '33.

RINEHART, ROY LOFTIN, M., resigned Apr. 5, '33.

SYLVESTER, HAROLD MACTAVISH, Jun., resigned March 22, '33.

Deaths

Beard, Arthur Garfield. Elected Assoc. M., Sept. 12, 1921; died March 10, 1933.

Burgess, Harry. Elected M., Oct. 5, 1909; died March 18, 1933.

Cornell, John Nelson Hayward. Elected Jun., May 1, 1898; M., June 1, 1909; died July 28, 1932.

Drum, Alphonsus Ligouri. Elected M., Oct. 1, 1913; died March 17, 1933.

Guthrie, Edward Buckingham. Elected Affiliate, Sept. 3, 1884; M., Oct. 5, 1887; died Feb. 28, 1933.

Halverson, George. Elected Assoc. M., July 6, 1925; died Apr. 1, 1933.

Harder, Harold Jay. Elected M., Apr. 25, 1921; died March 16, 1933.

Landon, Eugene Ashbel. Elected M., Apr. 1, 1896; died March 23, 1933.

Manning, Rollo Glenroy. Elected Assoc. M., Oct. 2, 1901; M., Oct. 30, 1906; died March 10, 1933.

Masury, Alfred Fellows. Elected Assoc. M., Jan. 6, 1915; M., Oct. 10, 1927; died Apr. 4, 1933.

Unwin, William Cawthorne. Elected Hon. M., June 19, 1922; died March 17, 1933.

Walker, Jesse Wager. Elected M., May 7, 1884; died Apr. 1, 1933.

Warren, Philip Ridsdale. Elected M., July 2, 1913; died March 6, 1933.

Wolff, Louis Peter. Elected M., June 30, 1910; died March 8, 1933.

Men Available

These items are from information furnished by the Engineering Societies Employment Service, with offices in Chicago, New York, and San Francisco. The Service is available to all members of the contributing societies. A complete statement of the procedure, the location of offices, and the fees is to be found on page 97 of the 1933 Year Book of the Society. To expedite publication, notices should be sent direct to the Employment Service, 31 West 39th Street, New York, N.Y. Employers should address replies to the key number, care of the New York office, unless the word Chicago or San Francisco follows the key number, when the reply should be sent to the office designated.

Construction

Graduate Engineer; Jun. Am. Soc. C.E.; 28; construction and design of highways, pipe lines, bridges; drafting and instrument experience. D-2029.

Construction Engineer and Superintendent; Assoc. M. Am. Soc. C.E.; 41; married; graduate; broad experience superintending engineering projects; large bridges, foundations, highway and railroad construction, and tunnel work. District engineer, general superintendent of highway location and construction in mountainous country and port development in tropics. Speaks Spanish. Qualified for responsible charge of projects, investigation, construction. Location and salary open. B-5200.

Estimator and Construction Engineer; Assoc. M. Am. Soc. C.E.; 39; married; graduate civil engineer; 18 years experience making up competitive bids on public and commercial projects; thoroughly familiar with all items in coordinating and expediting subcontracts and supervising field operations. Desires position with builder or contracting engineer. Location immaterial. B-4964.

Field Engineer; Jun. Am. Soc. C.E.; 24; single; B.S. in E., 1929; C.E., 1930; 3 years experience in construction, inspection, and estimating of subways and highways. Good computer, draftsman, and fieldman. Knowledge of architecture and accounting. Available immediately. Salary secondary. C-8128.

Civil Engineer; Jun. Am. Soc. C.E.; 27; B.S. in C.E.; 2 years real estate development, highway and sewerage construction; 3 years heavy construction on Bayonne Bridge and reconstruction of Cunard Pier No. 54; estimating experience. Desires connection with contractor or consulting engineers who can use an exact and efficient man. Location anywhere. C-3615.

Civil Engineer; Jun. Am. Soc. C.E.; 28; master's degree in hydraulics; 4 years experience in river and harbor work, concrete pier construction, round and sheet-pile work; in charge of survey and sounding parties; experienced in designing and drawing plans for floating plant. C-8619.

Design

Civil Engineer; Jun. Am. Soc. C.E.; 28; married; civil engineering degree from Polytechnic Institute of Brooklyn; special course in structural engineering; $9^1/_2$ years practical experience in structural steel design for subways, piers, pier sheds, tunnels, buildings in railroad yards, and elevated structures. Checker of shop drawings; excellent draftsman. Available immediately. Location anywhere. D-1754.

Civil Engineer; Assoc. M. Am. Soc. C.E.; 33; married; graduate C.E.; 10 years experience in the design of reinforced concrete and structural steel bridges, steel plants, blast furnace, skip bridges, indeterminate structures, and heavy foundations. Writes and speaks German and French perfectly. Suitable man for foreign work. Available at once. Location and salary secondary. Class A references. D-2019.

Civil and Industrial Engineer; M. Am. Soc. C.E.; graduate; licensed; 15 years experience in the design, construction, and rehabilitation of industrial plants of all kinds, warehouses, hydro-electric developments, housing groups, and commercial garages. Specification writing, purchase of construction materials, and supervision and direction of office and field forces. B-2835.

Civil Engineer; Assoc. M. Am. Soc. C.E.; 32; married; B.S. in C.E.; New Jersey structural license; $8^1/_2$ years experience detailing and designing concrete and steel railroad and highway bridges; 3 years experience on flat-slab, steel, and timber industrial buildings and 1 year on reinforced concrete dams. Desires field or office position. Location immaterial. D-1976.

Structural Designer; Assoc. M. Am. Soc. C.E.; 31; experienced on bridges, buildings, viaducts, caissons, foundations, bins, etc.; desires position; available immediately; will go anywhere; 10 years experience. C-8644.

Structural Designer and Salesman; M. Am. Soc. C.E.; 39; married; graduate C.E.; licensed; 18 years experience in structural designing, managing steel fabricating plant, and selling. Last 8 years head of consulting engineering office, specializing in structural designing for architects, owners, and contractors. Large acquaintance among architects and contractors in northern New Jersey and metropolitan New York. A-5489.

Bridge Engineer; M. Am. Soc. C.E.; 41; married; B.S. and M.S.; 17 years experience in designing and directing design work on highway and railroad bridges of all types in steel, stone, and concrete; 2 years teaching bridge engineering and theory of structures. Available immediately. D-1695.

Civil Engineer; Jun. Am. Soc. C.E.; 32; married; B.S. in C.E.; 7 years in architect's office as draftsman; 3 years in structural engineer's office on responsible design of steel framing, reinforced concrete foundations, retaining walls, slabs, etc. Desires field or office position Available immediately. D-2037.

Structural Designer; Assoc. M. Am. Soc. C.E.; 30; married; graduate of Rensselaer Polytechnic Institute; New York State licensed; 10 years experience; 8 years with consulting engineer—2 years charge of office—on fixed and movable, steel and concrete bridges, and structural design for buildings; excellent draftsman; proficient checker. Desires suitable connection with consultant, architect, fabricator, or contractor. D-506.

Executive

Executive; M. Am. Soc. C.E.; 25 years experience on railway maintenance, location, construction, and valuation; real estate development and house construction; last 12 years in South America on organization, engineering, and financial investigations and reports; real estate development and management; fair knowledge of accounting; speaks Spanish fluently; location immaterial. D-1992.

Engineer; M. Am. Soc. C.E.; 43; college graduate; licensed professional engineer and land surveyor, New York State; 17 years with one large public utility; 3 years with a large railroad; offers engineering or supervision service in gas, railway, highway, or municipal enterprises; good health; no objection to territory. C-5498.

Construction Engineer; Assoc. M. Am. Soc. C.E.; 41; married; graduate; professional engineer, Pennsylvania; 20 years experience on estimates, construction of piers, bulkheads, railroad yards, roundhouses, produce terminal, buildings, bridges, transmission lines, highways, warehouses, veterans' hospitals, coal silos, plant layout, pile driving, sewers, dredging, and land reclamation, surveys, topography. Available now. D-2033.

Reinforced Concrete Engineer and Concrete Technician; Jun. Am. Soc. C.E.; 32; married; B.S. in C.E.; 10 years experience in design and construction of pavements, bridges, and buildings; concrete control, sales promotion, office management. Desires position with architect, engineer, contractor, or as cement manufacturer's field engineer. Available immediately. D-1926.

Manager, Superintendent, Construction; M. Am. Soc. C.E.; 37; university graduate; married; 15 years on all types of foundations, dams, various structures, hydro-electric developments complete. Fully experienced organizer for cost and speed contract or other work, domestic and foreign, as well as planning and planting projects. Also estimating and designing experience. Available. C-9694.

Civil Engineer; Assoc. M. Am. Soc. C.E.; licensed professional engineer, New York State; 25 years experience in design and construction of steam and hydro-electric power plants, transmission lines of all capacities, including 220,000 volts, industrial plants, electric railways, valuations, estimates, specifications, and purchasing. Desires responsible charge of work. Location New York. B-5423.

Civil Engineer; Jun. Am. Soc. C.E.; 29; married; B.S. in C.E.; licensed professional engineer, Puerto Rico; 6 years experience as instrumentman, topographical draftsman, surveyor, inspector, assistant cost engineer, resident engineer, municipal engineering, development work, oil field and terminal construction, in Puerto Rico, New York, New Jersey, Venezuela, South America. Speaks Spanish fluently. Willing to travel. Available immediately. C-214.

Georgia Tech. Graduate Engineer; Assoc. M. Am. Soc. C.E.; 31; married; B.S. and C.E. degrees. Past 9 years with Louisiana Highway Commission—2 years as maintenance superintendent; 7 years on bridge construction as assistant and resident engineer. Just leaving million-dollar cantilever project over Red River. Efficient. Not afraid of work. Field or office. Best references. D-2056.

GRADUATE CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 9 years varied structural experience in drafting, design, surveys, and construction; also office and selling experience. Capacity to assume responsibility. Desires connection in field or office or any related work where most can be accomplished; also instructorship or sales-engineering. C-2605.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 30 years experience, chiefly specializing in food markets, cold storage, refrigeration; has had considerable experience as general manager for sales division of electric refrigerators, domestic and commercial. D-1516.

OFFICE ENGINEER (CIVIL); Assoc. M. Am. Soc. C.E.; 50; married. Topographer, hydrographer, draftsman, chartist, accountant, librarian, statistician. University education; 30 years experience—last 25 in immediate charge of technical and routine office work. Especially efficient with intricate details, graphic methods, and original research. Capable minor executive. Salary secondary. Location tertiary. D-2046.

JUNIOR

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 25; single; recent graduate with B.S. in civil engineering; 8 months railway experience in Southwest. Now employed in clerical position, but desires engineering work. Location immaterial. Will accept modest salary on anything permanent with future prospects of advancement. D-2025.

GRADUATE CIVIL ENGINEER; Jun. Am. Soc. C.E.; 21; single; C.E. degree, Rensselaer Polytechnic Institute, 1932; desires work in any branch of civil engineering; location immaterial; immediately available. D-1971.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 26; single; C.E. degree, Brooklyn Polytechnic Institute; 9 months surveying experience, transit man and chief of party; $4^1/_2$ years experience, drafting, computing, and estimating on subway construction. Desires any kind of job on construction, either field or office. Further experience paramount. Salary secondary. Location immaterial. Can start immediately. C-3168.

GRADUATE CIVIL ENGINEER; Jun. Am. Soc. C.E.; 26; married; B.S. and C.E.; 4 years experience, topographic, hydrographic, triangulation, real estate, easement, precise traverse, and construction surveys. Extensive precise leveling. Inspection and estimating rock shafts, tunnels. Good draftsman. Teaching experience. Location and salary immaterial. Available immediately. C-6151.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 26; B.S. in C.E., New York University, 1930; 1 year on Holland Tunnel; $2^1/_2$ years as assistant engineer for general contractor on sub-river tunnels; draftsman; estimating and computing steel, concrete, waterproofing, etc.; building inspection, electric welding, and building settlements. Desires work with contractor anywhere. D-1921.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 26; single; B.S. in C.E., New York University, 1929; $3^1/_2$ years with the Long Island Railroad on grade-crossing eliminations. Experienced in all phases of work—surveying, estimating, railroad R. and E. accounting, specifications. Desires position in any branch of civil engineering. Salary immaterial. C-6244.

ENGINEER; Jun. Am. Soc. C.E.; 25; single; New York University, 1929; 1 year on building construction; 3 years with Westchester County Highway Department, design and construction of concrete and other types of pavement; computation and drafting right-of-way property; survey computations and field work. Position desired with engineer or contractor. D-1981.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 26; single; B.S. in C.E., Rutgers University, 1930; $1^2/_3$ years as transitman in Essex County Highway Department; passed New Jersey State civil service senior draftsman examination. Desires working or teaching position in any branch of civil engineering, preferably one involving mathematics. D-663.

CIVIL ENGINEERING GRADUATE; Jun. Am. Soc. C.E.; 22; single; B.S. in C.E. (highway option), University of Illinois, 1932; Tau Beta Pi. Doing subgrade soil research; expects M.S. in C.E., June 1933. Prepared for position in any branch of civil engineering, preferably highway or structural. Location immaterial. Available June 14, 1933. D-2043.

JUNIOR CIVIL ENGINEER; Jun. Am. Soc. C.E.; 24; single; B.S. in C.E., Drexel Institute, 1931; 2 years on engineering corps on railroad and highway construction, both field and office, including surveys, inspecting, computing, and drafting. Good computer. Desires any engineering connection, any location. D-2053.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 27; B.S. in C.E., Rutgers University; M.S. in C.E., University of Illinois; 2 years structural research at Engineering Experiment Station; licensed stationary engineer, New Jersey, steam and refrigeration; 2 years drafting and surveying; French and German; Sigma Xi; desires research, teaching, or practical position. C-9263.

MISCELLANEOUS

CONSULTING ENGINEER; M. Am. Soc. C.E. Especially qualified to serve as adviser to banks and investment houses concerning foreign investments. Wide experience in Latin America; 4 years recent experience in China. Available after June 1. D-2026.

RESEARCH

SANITARY AND CIVIL ENGINEER; Jun. Am. Soc. C.E.; 29; married; B.S. from Iowa State College; M.S. from West Virginia University; registered professional engineer, Iowa; 4 years practical experience; 2 years research and assistant teaching. Location immaterial. C-7471.

SALES

STRUCTURAL SALES ENGINEER; M. Am. Soc. C.E.; 45; married. Over 20 years continuous and successful experience in supervising competition, designing, estimating, and sales of modern steel, fabricating business. Offers exceptional advantages. Desires interview. C-5095.

TEACHING

INSTRUCTOR IN MATHEMATICS AND ENGINEERING; Jun. Am. Soc. C.E.; unmarried; B.S. in C.E. from Massachusetts Institute of Technology; 4 years experience teaching differential and integral calculus; 6 years experience in all branches of building construction industry, both field and office work; desires full-time teaching position for the year 1933–1934. Location immaterial. C-3262.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; graduate; state licenses; 13 years experience with technical and executive responsibility in surveys, investigations, industrial plant design and erection, hydraulic structures, etc., with an interlude of teaching. Thoroughly acquainted with modern engineering literature. Desires position teaching undergraduate courses. C-7235.

ASSOCIATE PROFESSOR STRUCTURAL ENGINEERING; Assoc. M. Am. Soc. C.E.; married; degrees B.S., M.S., and C.E., University of Illinois; 3 years experience teaching major courses, structural theory and design in ranking university; 5 years practice, reinforced concrete and steel structures, chiefly with Waddell and Hardesty, consultants, on cantilever, arch, suspension, movable, continuous-girder spans; technical writer; world-traveler. Desires position, leading university. D-330.

ASSOCIATE PROFESSOR OF CIVIL ENGINEERING; Assoc. M. Am. Soc. C.E.; 32; licensed structural engineer; degrees B.S. and C.E.; 2 years postgraduate work; 5 years experience teaching civil engineering subjects, chiefly structural, in Eastern university; $3^1/_2$ years experience on steel structures; with large fabricating company at present. C-6854.

CIVIL ENGINEER; M. Am. Soc. C.E.; Member S.P.E.E.; married; degrees B.S., C.E., M.S.; 13 years successful teaching experience in one college; 4 years practical experience. Desires teaching position in civil engineering or applied mechanics. D-302.

ASSISTANT PROFESSOR OF CIVIL OR MINING ENGINEERING; Assoc. M. Am. Soc. C.E.; 36; married; licensed professional engineer, New Jersey; graduate, engineer of mines; previous teaching experience; 11 years practical engineering experience, field and office; desires position with department of engineering in university. Location and salary open. B-6016.

RECENT BOOKS

New books of interest to Civil Engineers, recently donated by the publishers to the Engineering Societies Library, will be found listed here. A comprehensive statement regarding the service which the Library makes available to members is to be found on page 87 of the Year Book for 1933. The statements made regarding the books are taken from the books themselves and this Society is not responsible for them.

BILDWORT ENGLISCH TECHNISCHE SPRACHHEFTE. 4. TRANSPORTATION. Berlin, VDI-Verlag, 1932. 33 pp., diagrs., 8 × 6 in., paper, 1.50 rm.

Intended to assist German transportation engineers who wish to improve their knowledge of the English language. An English-German glossary is given. Transportation by land, air, and water is considered.

L'ÉCOULEMENT EN CONDUITES DES LIQUIDES, GAZ ET VAPEURS. By A. Schlag. Paris, Dunod, 1933. 182 pp., diagrs., charts, tables, 8 × 5 in., paper, 18 frs.

Current formulas for determining the flow of fluids are presented, with a concise description of the theories and experimental data upon which they are based. A bibliography is included.

HYDRAULIC MACHINERY. By D. W. Mead. New York and London, McGraw-Hill Book Company, 1933. 396 pp., illus., diagrs., charts, tables, 10 × 6 in., cloth, $4.

The first third of this book deals with the general principles of hydraulic machinery and with methods of generating and using power in general. It includes a method of plant analysis by which alternative methods of power generation and utilization can be compared and the best selected. The remainder of the volume discusses pumping machinery, with special attention to small installations.

PLANNING PROBLEMS OF TOWN, CITY, AND REGION, presented at the twenty-fourth National Conference on City Planning, Pittsburgh, Nov. 14–16, 1932. Philadelphia, Wm. F. Fell Company, 1932. 158 pp., charts, tables, 9 × 6 in., cloth, $3.

The views of 21 experts upon a variety of subjects. The relation of planning to housing programs and to taxes, budgeting, methods of making planning more effective, the range of the planning field, and other topics are discussed.

PUBLIC UTILITY REGULATION. By W. E. Mosher and F. G. Crawford. New York and London, Harper and Brothers, 1933. 612 pp., tables, 9 × 6 in., cloth, $5.

This book is a study of the scope and effectiveness of present methods of regulating public utilities through public service commissions. Stress is laid on administrative aspects of regulation rather than legal and economic ones, although these are also considered.

STRENGTH OF MATERIALS. By J. P. Kottcamp and A. C. Harper. New York, John Wiley and Sons, 1932. 214 pp., illus., diagrs., charts, tables, 8 × 5 in., cloth, $1.75.

The aim of this book is to present the fundamental principles of the subject, with a minimum of mathematics and from the viewpoint of the needs of industrial schools. The application of strength of materials in proportioning beams, columns, shafting and riveted joints, and in problems involving simple stresses is discussed. The new edition has been thoroughly revised and largely rewritten.

VALUATION OF REAL ESTATE. By F. M. Babcock. New York and London, McGraw-Hill Book Company, 1932. 593 pp., illus., diagrs., charts, tables, 9 × 6 in., paper, $5.

Beginning with a discussion of the economic background of real-estate values, this book develops a theory of valuation and then applies the theory to practical problems, based upon ordinary properties and covering the type of problem usually met.

CURRENT PERIODICAL LITERATURE

Abstracts of Articles on Civil Engineering Subjects from Magazines in This Country and in Foreign Lands

Selected items from the current Civil Engineering Group of the Engineering Index Service, 29 West 39th Street, New York, N.Y. Every article indexed is on file in The Engineering Societies Library, one of the leading technical libraries of the world. Some 2,000 technical publications from 40 countries in 20 languages are received by the Library and are read, abstracted, and indexed by trained engineers. With the information given in the items which follow, you may obtain the article from your own files, from your local library, or direct from the publisher. Photoprints will be supplied by this library at the cost of reproduction, 25 cents per page, plus postage, or technical translations of the complete text may be obtained at cost.

BRIDGES

Australia. New Bridge at Brisbane, Australia. *Engineer*, vol. 155, no. 4024, Feb. 24, 1933, pp. 186, 187, and 196. Grey Street Bridge has a total length, with its approaches, of 1,634 ft; it crosses the river on three arches, each of 238-ft span, and the lower North Quay Road on two reinforced concrete spans of 33-ft centers; the bridge proper is constructed of steel arches encased in concrete, from which the decking is supported by stringers.

Bridge Piers, Concrete. Proportioning, Mixing, and Placing of Concrete Piers, W. A. Scott. *Concrete*, vol. 41, no. 3, March 1933, pp. 19 and 20. Transit-mixed concrete utilized for the construction of 16 concrete piers for the St. Johns Bridge across the Willamette River, Portland, Ore.; careful control of quality; aggregates up to 3 in. in size used.

Concrete Arch, Belgium. Le nouveau pont de Visé, M. J. Lekenne. *Annales des Travaux Publics de Belgique*, vol. 33, no. 5, Oct. 1932, pp. 749–783. 1 supp. plate. Design and construction of concrete highway bridge, consisting principally of four 3-hinged arches up to 53 m in span; details of foundation and temporary centering of arches.

Concrete Arch, Pittsburgh, Pa. George Westinghouse Memorial Bridge. *Universal Engr.*, vol. 57, no. 2, Feb. 1933, pp. 14–18. 5-span, reinforced concrete arch bridge, 1,560 ft long, has a roadway 42 ft wide, which provides for four lanes of traffic; outstanding features; it is estimated that structure will save over $435,000 yearly; center span is the longest concrete arch in America.

Concrete Girder. Beauty of Design Sought in Queens Parkway Bridges, C. U. Powell. *Eng. News-Rec.*, vol. 110, no. 10, March 9, 1933, pp. 316–319. Description of completed bridges on the Grand Central Parkway, between Kew Gardens and the line separating New York City from Nassau County; eight rigid-frame bridges, having spans up to 86 ft in length.

Design. Die Berechnung raeumlich gekruemmter Stahlbruecken, H. Gottfeldt. *Bautechnik*, vol. 110, no. 54, Dec. 16, 1932, pp. 715–724. Theoretical mathematical discussion of the design of steel bridges curved in three dimensions, including case of single span bridge; design of girders curved in three dimensions; approximate formulas.

Highway, Design. Design of Approaches to Highway Bridges, H. Criswell. *Roads and Road Construction*, vol. 5, no. 122, Feb. 1, 1933, pp. 37–40. Vertical alignment of new bridges with ascending approaches; single short span; long series of spans; longitudinal section of approaches. (To be continued.)

Maintenance and Repair. Expansion and Moving Fill Damage Bridge Concrete. *Eng. News-Rec.*, vol. 110, no. 11, March 16, 1933, pp. 346–349. 15-year-old Hanover St. Bridge in Baltimore, 2,290 ft long, requires numerous repairs to concrete at expansion joints and in column footings; plan showing itemized damage sustained from foundation movements; repair methods.

Railroad, Africa. New Lower Zambesi Bridge. *Ry. Gaz.*, vol. 58, no. 7, Feb. 17, 1933, pp. 208–211. Main features of railroad bridge in Nyasaland Protectorate, which will total 2.3 miles in length and will have a span up to 262.5 ft in length.

Steel, Welding. Repairs to Railroad and Highway Bridges by Electric Welding, A. G. Leake. *Am. Welding Soc.—Journal*, vol. 12, no. 2, Feb. 1933, pp. 30 and 31. Method of repairing and strengthening weak or corroded joints in pin-connected eye-bar bridges and of building up additional bearing on the pins without the use of falsework; savings of from 25 to 80 per cent.

Steel Truss, Siam. Bangkok Memorial Bridge. *Far East Rev.*, vol. 29, no. 1, Jan. 1933, pp. 28–34. Design and construction of steel lattice girder through-type bridge, comprising two spans 247 ft long and a central opening of 196 ft spanned by a double-leaf bascule, electrically operated; bridge approaches; erection procedure; construction contract let for £250,141.

Suspension. How "Big" Is a Bridge? *Wire Eng.*, vol. 2, no. 3, Jan. 1933, pp. 39–44 and 48; see also *Eng. News-Rec.*, vol. 110, no. 11, March 16, 1933, pp. 349–350. Ten largest American suspension bridges compared on basis of span length and length of one cable.

Nouvelles recherches sur le calcul des ponts suspendus, J. Karpinski. *Annales des Travaux Publics de Belgique*, vol. 33, no. 5, Oct. 1932, pp. 685–722. Review of recent progress in design of suspension bridges, with special reference to work of Moisseiff, Ammann, and Timoschenko.

Viaducts, Winnipeg. Salter Street Viaduct Over C. P. R. Tracks at Winnipeg, H. N. Halland. *Can. Engr.*, vol. 64, no. 8, Feb. 21, 1933, pp. 5–8. Description of recently completed viaduct, having a total length of 2,170 ft and comprising three types of construction; earth-fill abutment, steel bridge over tracks, and two concrete structures; roadway width is 50 ft between curbs with two 6-ft walkways.

Wooden. Treated Timber in Highway Bridges. *Timberman*, vol. 34, no. 4, Feb. 1933, pp. 12, 13, and 24. Factors of short-span bridge, which eliminate many defects inherent in ordinary timber trestles of the past and which bid fair to compare favorably with concrete-trestle or viaduct construction; table giving estimate was made on the basis of a thorough checking of the structure every five years.

BUILDINGS

Construction. Gantry Crane Erects Heavy Stone Columns, G. S. Merts. *Eng. News-Rec.*, vol. 110, no. 12, March 23, 1933, pp. 365–366. Description of new building for Mellon Institute of Industrial Research, in Pittsburgh, Pa.; 62 monolithic stone columns weighing 60 tons each were set in record time; erection equipment for setting stone columns; special clamp and balance-beam apparatus used in handling columns.

Exhibition Buildings, Chicago. Exposition Buildings Unique in Form and Structure, C. W. Farrier. *Eng. News-Rec.*, vol. 110, no. 9, March 2, 1933, pp. 278–282. Century of Progress exposition plan; office building on spread footings; steel frames and floors; composition-board walls; interior decoration; walls form ventilation flues; wallboards of plywood and gypsum; pile foundations; fire precautions; mass effect instead of decoration; low-cost construction; permanency possibilities of construction methods.

High Buildings. Height Limits for Tall Buildings Based on Plot Area, J. Feld. *Eng. News-Rec.*, vol. 110, no. 10, March 9, 1933, p. 315. Discussion of economic height of buildings based on a survey of 331 residential and office buildings in New York City, of 20 or more stories in height; the approximate formula against the number of stories is equal to the area of the plot divided by 700.

Vibrations. Les graves inconvénients de la résonance due aux machines installées dans les bâtiments, I. Katel. *Bul. Technique de la Suisse Romande*, vol. 58, no. 24, Nov. 26, 1932, pp. 312–315. Analysis of data on extreme vibration resonance in buildings resulting from machines installed in them.

Wind Bracing. Wind Bracing, A. Smith. *West. Soc. Engrs.—Journal*, vol. 38, no. 1, Feb. 1933, pp. 1–18. Critical review of the theories of wind stresses and bracing of buildings, including unsymmetrical buildings; provisions of building codes for fiber stress in columns; bracing scales.

CITY AND REGIONAL PLANNING

Housing. Progress in Housing. *Arch. Rec.*, vol. 73, no. 3, March 1933, pp. 147–168, and (adv. sec.) 30 and 32. Symposium consisting of following: Summary of Activities by Architects and Associations; Cleveland Housing Studies, W. R. McCornack; Plan of Boulder City, Nev., S. R. de Boer; Chicago Housing Project, G. F. Keck and R. P. Schweihker; Negro Housing Proposed for Richmond, Va., A. Kastner.

CONCRETE

Aggregates, Grading. Effects of Particle Interference in Mortars and Concretes, C. A. G. Weymouth. *Rock Products*, vol. 36, no. 2, Feb. 25, 1933, pp. 26–30. Function of grading of aggregates; theory of particle interference; efforts to set up ideal gradings must take into account water-cement ratio and consistency; it is simpler to examine gradings of commercial aggregates and correct them by addition of those sizes in which gradings appear to be deficient.

Construction. New Facts About Cement and Concrete—I. *Eng. News-Rec.*, vol. 110, no. 10, March 9, 1933, pp. 322–325. Abstracts of papers presented at the 1933 meeting of the American Concrete Institute, giving first published results of the research program, guiding construction of Hoover Dam; shrinkage in cooling; joint grouting; effect of cement composition; aggregate and specimen size; make-up of cylinders; measuring elasticity; field-control test; heat constants and aggregates; cement studies.

New Facts About Cement and Concrete—II. *Eng. News-Rec.*, vol. 110, no. 11, March 16, 1933, pp. 350–352. Vibration studies at Berkeley; vibration studies at Chicago; vibration in road-building; concrete quality and economy; reinforced concrete columns; relation between compressive strength and cement content for vibrated and hand-placed concrete. (Concluded.)

Construction, Forms. Strength of Nailed Joints in Shuttering, G. P. Manning. *Concrete and Constr. Eng.*, vol. 28, no. 3, March 1933, pp. 193–195. Tests to determine strength of joints as used in everyday concrete forms; forms of failure of joints; all tests were carried out on 100,000-lb Riehle machine at speed of 0.05 in. per min, and all timber used was ordinary deal.

Floors. Forms for Concrete Joint Construction Floors. *U.S. Bur. Standards—Simplified Practice Recommendation R87—32* (Second Edition) 1932. 13 pp. Designated by American Standards Association as American Standard A48-1932.

Properties. Einfluesse auf die Verarbeitbarkeit des Betons, K. Walz. *Zement*, vol. 22, nos. 6 and 7, Feb. 9, 1933, pp. 78–81, and Feb. 16, pp. 93–95. Influence of composition and aggregates on the workability of concrete; report of investigations at materials testing laboratory in Stuttgart; influence of cement, water content, aggregates, and admixtures; external influences.

Protective Coatings, Cement. Zement und Beton als Rostschutzmittel, R. Gruen. *Zement*, vol. 22, no. 5, Feb. 2, 1933, pp. 66–68. Cement and concrete as protective agents against corrosion; examples of their use for the protection of steel structures, plates, and tubes; distinction between the use of pure cement and mortar or concrete.

Roads and Streets, Concrete. How Ohio's Highway Department Uses Transit-Mixed Concrete, H. P. Chapman. *Concrete*, vol. 41, no. 3, March 1933, pp. 3 and 4. Spreading concrete over subgrade; how strength requirement is satisfied and use of truck-mixed concrete was increased in 1932. Before Nat. Ready-Mixed Concrete Ass'n.

Sand and Gravel Plants, Oklahoma. Sand and Gravel Plant with Unusual Features. *Rock Products*, vol. 36, no. 2, Feb. 25, 1933, pp. 21–24. Operation and equipment at plant of Makins Sand and Gravel Company at Sulphur, Okla.; gravel deposit consists of cemented conglomerate; material loaded out by belt conveyors; ready-mixed concrete operations.

CONSTRUCTION INDUSTRY

Chicago Exposition. Construction Management Stressed Over Technique, J. Stewart. *Eng. News-Rec.*, vol. 110, no. 9, March 2, 1933, pp. 289-293. Organization and operation of

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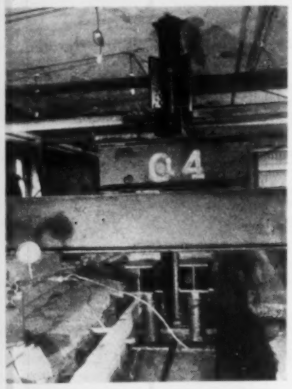

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construction units of Century of Progress Exposition in Chicago; financing, contracts, and supervision; progress and costs; operations and methods; welding extensively employed for light steel connections.

Costs. Unit Bid Summary. *West. Construction News and Highways Bldr.*, vol. 8, no. 5, March 10, 1933, pp. 148, 150, 152, and supp. pp. 42, 44, 46, and 48. Unit costs bid on bridge construction, street and road work, pipe-line construction and machinery and equipment, in California, Nevada, and Oregon.

DAMS

Cement, Specifications. Specification for Cement with Low Heat Generation During Hydration. *Cement and Cement Mfr.*, vol. 6, no. 2, Feb. 1933, pp. 39–43. Discussion of specifications for cement used in the construction of massive concrete dams in the United States, such as Pine Canyon Dam, in California, and Hoover Dam.

Hydro-Electric Power Developments, Switzerland. L'aménagement de la chute de Pizancon sur l'Isère, Ch. Magnenat. *Bul. Technique de la Suisse Romande*, vol. 58, nos. 2 and 3, Jan. 21, 1933, pp. 13–19, and Feb. 4, pp. 29–34. Description of the 56,000-hp hydro-electric power development at Pizancon on the Isère River, including Stoney gate weir, over 13 m high, consisting of six 15-m bays; details of concrete construction, mechanical and electric equipment.

FLOOD CONTROL

New England. Discussion of "Report of Committee on Floods" of Boston Society of Civil Engineers. *Boston Soc. Civ. Engrs.—Journal*, vol. 19, no. 10, Dec. 1932, pp. 491–545. Discussion, by G. H. Matthes, J. W. Gross, J. H. Kimball, and others, of paper indexed in Engineering Index, 1930, p. 738, from the issue of Sept. 1930.

FLOW OF FLUIDS

Anemometers. Improved Apparatus for Measurement of Fluctuations of Air Speed in Turbulent Flow, W. C. Mock, Jr., and H. L. Dryden. *Nat. Advisory Committee Aeronautics—Report*, no. 448, 1932, 26 pp. Response of hot-wire anemometer to speed fluctuations; methods of compensating for lag of wire, and experimental determinations of the performance of wire and compensating circuit; design of amplifiers for use in turbulence measurements; experiments on frequency distribution of speed fluctuations in wind tunnel.

HYDROLOGY, METEOROLOGY, AND SEISMOGRAPHY

Earthquakes, California. Building Damage Sustained in California Earthquake, J. I. Ballard. *Eng. News-Rec.*, vol. 110, no. 12, March 23, 1933, pp. 378–381. Long Beach earthquake did no damage to structural frames of major buildings; many deaths caused by falling debris, but few structures collapsed; failure of brick masonry outstanding; minor damage to residences and public works.

Destructive Earthquake Centers on Long Beach, California. *Eng. News-Rec.*, vol. 110, no. 11, March 16, 1933, pp. 353–355. Series of shocks, starting on evening of March 10, does $50,000,000 damage, mostly to poorly built structures, and takes over 100 lives; Los Angeles is among 30 cities affected, but damage there is slight; sound construction stood up; utilities not damaged; quake instruments function.

Earthquakes, Cuba. Aspecto Geografico, Geologico y Sismico del Megasismo de Santiago de Cuba de 3 de Febrero de 1932, E. I. Montoulieu. *Revista de la Sociedad Cubana de Ingenieros*, vol. 25, no. 1, Jan.-Feb. 1933, pp. 5–79. Report on the geographic, geological, and seismic aspect of the extensive earth movement at Santiago de Cuba, Feb. 3, 1932.

Earthquakes, New Zealand. Taupo Earthquakes, 1922, L. I. Grange. *New Zealand Journal Science and Technology*, vol. 14, no. 3, Dec. 1932, pp. 139–141. Notes on rents and faults formed during earthquakes, between May and Dec. 1922, in the Taupo District of the north island of New Zealand.

Meteorites, Nebraska. Second Story Meteorite from Nebraska, H. H. Nininger. *Am. Mineralogist*, vol. 18, no. 2, Feb. 1933, pp. 56–59. Notes on aerolite said to have been found near Cotesfield, Nebr., about 1928 and now in collection of the Museum of Natural History.

Rain and Rainfall. Round Table. *Water Works Eng.*, vol. 86, no. 5, March 8, 1933, pp. 195–197. Discussion, by practical water-works engineers, of the uses of rainfall information furnished by the U.S. Weather Bureau stations; suggestions for increasing usefulness of data.

Rainfall, Great Britain. British Rainfall Organization, E. G. Bilham. *Water and Water Eng.*, vol. 35, no. 414, Feb. 20, 1933, pp. 61–64. Outline of organization; local rainfall organizations; extraction, charting, and publication of data; averages; run-off; professional work; research work. Bibliography.

Structures, Earthquake Effect. Engineering Structures in Regions Subject to Earthquakes. *Concrete and Constr. Eng.*, vol. 28, no. 3, March 1933, pp. 214–216. Extracts of papers to be brought forward for discussion at Institution of Civil Engineers; Influence of Earthquakes on Structural Design, H. C. E. Cherry; Effect of Earthquakes on Engineering Structures, F. W. Furkert; Design of Earthquake-Resisting Structure, J. J. Booth.

Water Wells, Hydrology. Computing Effective Diameter of Well Battery by Means of Darcy's Law, O. L. Eliason and W. Gardner. *Agric. Eng.*, vol. 14, no. 2, Feb. 1933, pp. 53 and 54. Computation of effective diameters for the battery of wells penetrating uniform horizontal stratum of water-bearing gravel bounded above and below by impervious layers; water pumped from such depth as to ensure horizontal movement.

IRRIGATION

Financing. Western Irrigation District Successfully Refinanced, W. Durbrow. *Eng. News-Rec.*, vol. 110, no. 10, March 9, 1933, pp. 312–314. Refunding an $8,100,000 debt in the refinancing of the Nevada Irrigation District of California; all but 2 per cent of bond-holders accepted new 4 per cent bonds in place of $5^1/_2$ per cent originals; procedure sets precedent for future refinancing; legal preliminaries.

Water Law, Germany. Das neue Thueringische Wassergesetz unter besonderer Beruecksichtigung der Fabrikabwaesserfrage, L. Longard. *Kali*, vol. 27, nos. 2, 3, and 4, Jan. 15, 1933, pp. 15–18; Feb. 1, pp. 27–30; and Feb. 15, pp. 41–43. New Thuringian water law, with special regard to industrial waste-water problem; regulation of waste-water disposal according to new law.

PORTS AND MARITIME STRUCTURES

Callao, Peru. Improving Peruvian Port of Callao, S. A. Wee. *Excavating Engr.*, vol. 27, no. 3, March 1933, pp. 109–113 and 134–136. Modernization of the port; some 5,000 precast concrete piles used for docks; three miles of breakwater; dredging 2,200,000 cu yd; 120-ft piling in trestles; silt and sand layers cause serious difficulties; tunnel method used for blasting; tits and winzes found most practical for carrying charges; experience in blasting itemized.

New Zealand. Greymouth Harbor—New Zealand, E. C. Schnackenberg. *Roy. Engrs. Journal*, vol. 47, March 1933, pp. 56–72, 4 supp. plates. Description of physical features of the harbor; cost data and engineering details of large quarry blast involving 14,600 lb of powder; calculation of charges; ignition system; cost of tunneling.

Pollution. Pollution of New York Harbor, E. B. Phelps and C. J. Velz. *Sewage Works Journal*, vol. 5, no. 1, Jan. 1933, pp. 117–157. Study of the relation between the total sewage pollution and the resultant harbor condition as influenced by various physical factors; relation between fluctuations in the dissolved oxygen of the upper bay and the summer run-off of the Hudson River; pollution of the upper Hudson; flow of sea water into harbor; salinity gradient.

Sea Walls, Construction. Sea-Wall and Cliff Improvement at Tynemouth, J. Mitchell. *Inst. Mun. and County Engrs.—Journal*, vol. 59, no. 17, Feb. 14, 1933, pp. 917–927. Construction of a sea wall 880 ft long, with a cope-level $11^1/_2$ ft above the high water of ordinary spring tides, founded throughout upon shale rock.

ROADS AND STREETS

Asphalt. Asphalt Road Construction. Surface Treatment Types. Asphalt Inst. Manual, no. 2, 1932, 128 pp. Definitions and history of surface treatment; asphaltic products used; types of surfaces and cover coat aggregates; influence of roadbed upon stability of surface; traffic capacity of road surfaces and preparation for original treatment; surface treatment on surfaces of selected aggregates; maintenance; labor, equipment, tools; specifications; tests and control; service records and costs; useful tables.

Vorlaeufiges Merkblatt ueber die Herstellung rauher Strassenbelaege unter Verwendung von Asphaltbitumen. *Petroleum*, vol. 29, no. 3, Jan. 18, 1933, pp. 11 and 12. Tentative specification for the manufacture of rough road surfacing materials by the use of asphalt bitumen; special reference to methods of increasing roughness of surface.

Asphalt Emulsions. Low-Cost Road Construction with Asphalt Emulsions, J. A. Shaw. *Am. City*, vol. 48, no. 3, March 1933, pp. 43 and 44. Advantages of asphalt emulsion; inexpensive construction; penetration macadam; retread and road mix. Before Rhode Island Highway Ass'n.

Bituminous Materials, Testing. Physical Properties of Mixtures of Bitumen and Finely Divided Mineral Matter, A. Evans. *Inst. Petroleum Technologists—Journal*, vol. 18, no. 110, Dec. 1932, pp. 957–991. Research on the properties of mixtures of residual bitumens with various types of mineral matter or filler; materials; apparatus; procedure; results show that physical and mechanical properties of asphaltic cements are so profoundly affected by nature and the proportion of filler used, that it is as essential to determine the properties of asphaltic cement as those of the bitumen itself.

Brick. Recent Practical Developments in Design and Construction of Brick Pavements. *Am. Road Bldrs.' Ass'n—Convention Proc.*, Jan. 11–15, 1932, Bul. no. 34, pp. 3–17. Report of committee of the American Road Builders' Association; base courses of foundations; bedding course (cushion); brick course; filler; standard filler specifications; application; relaying, replacement, resurfacing, etc.

Cement - Bound. Cement - Bound Roads. *Roads and Road Construction*, vol. 11, no. 122, Feb. 1, 1933, pp. 41 and 42. Quality and adequacy; grouted and sandwich cement-bound roads; structural control; cement grouting in Australia; sandwich system; sandwich system in Ireland.

Concrete. Concrete Roads. *Engineer*, vol. 155, no. 4024, Feb. 24, 1933, pp. 202–203. McLea system of construction in which the top layer of concrete is placed in pockets of steel meshwork; steelwork is formed from mild steel strip bent into short zigzag lengths and held loosely in position by steel rods passed through holes pierced in angles.

Place Truck-Mixed Highway Concrete with Mechanical Spreader. *Concrete*, vol. 41, no. 3, March 1933, p. 17. Mechanical concrete spreader manufactured by the Jaeger Machine Company received concrete from side-dump truck mixers of 5-cu yd capacity.

Construction. Trans-Canada Highway, J. Sinton. *Eng. Inst. Can.—Journal*, vol. 16, no. 3, March 1933, pp. 107–111. Construction of the Ontario section of this highway as an unemployment relief measure; general policy, organization, construction, and methods of securing and distributing labor and supplies; work accomplished covered 300 miles of new construction and about the same mileage of reconstruction; standard cross sections and super-elevation data for 30-ft roadway.

Costs. Unit Bid Summary. *West. Construction News and Highways Bldr.*, vol. 8, no. 4, Feb. 25, 1933, pp. 112, 114, and 116. Unit costs bid on street and road work, in California, Washington, New Mexico, and Montana.

Curves. Rectifying Road Curves, F. G. Royal—Dawson. *Roads and Road Construction*, vol. 11, no. 122, Feb. 1, 1933, pp. 57 and 58 (discussion) 59 and 60. Nature of super-elevation; example; existing curves; super-elevating circular arcs; limits of transition; curves of large radius. (Concluded.)

Great Britain. Road Surfacing Materials and Plant. *Quarry and Roadmaking (Special No.)*, vol. 38, no. 435, Feb. 21, 1933, pp. 88–100. Review of modern proprietary materials and surface dressings, together with details of mechanical plant, available for use in connection with modern road-surfacing practice.

Highway Administration. Organization of Township Road Systems, P. M. Higgins. *Can. Engr. (Convention No.)*, March 7, 1933, pp. 50, 52, 54, and 56. Functions of township council, road superintendent, patrolmen, and district engineers.

Highway Engineering. Roads Number. *Contract Rec.*, vol. 47, no. 8, Feb. 22, 1933, pp. 163–214 and supp. pp. 82, 84, and 86. Ingenious Device for Casting Sand on Icy Roads; Paved Invert Pipe for Outfall Sewer at Guelph; Construction of Trans-Canada Highway (Ontario Section) as an Unemployment Relief Measure, J. Sinton; Highway Lighting from Standpoint of Taxpayer, M. B. Hastings; New Ideas in Road Building Equipment; Organization for County Highway Maintenance; Highway Department Officials.

Highway Lighting. Facts and Figures Show Urgent Necessity for Highway Lighting. *Contract Rec.*, vol. 47, no. 10, March 8, 1933, pp. 244–247. At least 37 per cent of all winter accidents are due to insufficient illumination; large fatalities on rural highways; price of accidents; economical advantages in lighting; low lighting maintenance costs.

Low-Cost. Low-Cost Road Practices in North Atlantic States. *Eng. News-Rec.*, vol. 110, no. 10, March 9, 1933, pp. 319–321. Symposium consisting of the following: Road-Mix Gravel and Stone in Vermont, H. E. Sargent; Surface-Treated Gravel in New Jersey, E. E. Reed; Emulsion-Penetrated Stone in Maine, E. L. Merrill; Oiled Bank-Run Gravel in Maryland, C. B. Bryant; Traffic-Bound Macadam in Delaware, Wm. A. McWilliams; Low-Cost Water-bound Macadam in Connecticut, A. W. Bushell; Road Mix and Penetration Combined in New York, E. C. Lawton.

Maintenance and Repair. Maintenance of Highways in Winter, G. R. Marston. *Can. Engr. (Convention No.)*, March 7, 1933, pp. 58 and 60. Report of County Engineer, Norfolk County, Ontario, on various conditions in the Province and on methods of dealing with snow;

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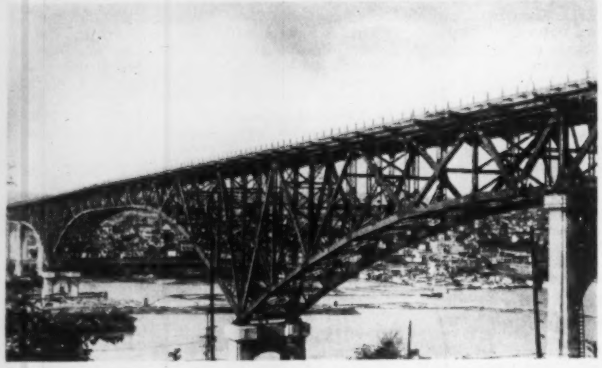

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powers under highway improvement act; responsibility of road authorities; prevention of snow drifting.

Use of Mechanical Appliances for Repair of Roads, G. Bolsover. *Inst. Mun. and County Engrs.—Journal*, vol. 59, no. 18, Feb. 28, 1933, pp. 941–964. Opening, consolidation, and reinstatement of trenches; widening, reshaping, and resurfacing of existing roads; surface dressing with hot and cold materials; gritting against frost and snow; repair of concrete roads; cost data.

Military Engineering, United States. Road Problem of Force Operating in Undeveloped Country, C. M. Singer. *Roy. Engrs. Journal*, vol. 47, March 1933, pp. 36–55. Road requirements of force; how far the art of roadmaking in its present state can be made to satisfy these requirements; organization, equipment, and training necessary to enable work to be carried out.

Ontario. Ontario Good Roads Convention. *Can. Engr.* (*Convention No.*), March 7, 1933, pp. 25–46. Verbatim report of the thirty-first annual meeting and speeches at the annual banquet, including the following papers: Ontario's Highway Program—Its Present Status and Outlook for Future, R. M. Smith; Highway Finance, Particularly with Regard to County Road Problems, T. J. Mahony; History and Function of County Road System, C. Talbot; Road Work in Northern Ontario Under Department of Northern Development, J. Sinton; Township Road—Farmers' Road, L. W. Harkness; Township Roads, S. A. Brown; Safety on Highways, J. T. Bickell.

Roadmaking. Roadmaking and Roadmaking Equipment, G. S. Barry. *Quarry and Roadmaking* (*Special No.*), vol. 38, no. 435, Feb. 21, 1933, pp. 83–87. General discussion of modern roadmaking methods; subsoil drainage; foundation work; formation of crust; footpaths; surface treatment; plant. Before Scientific Soc. of Roy. Tech. College.

Viaducts, Concrete. Widening Yolo Causeway Near Sacramento, A. G. Darwin. *West. Construction News and Highways Bldr.*, vol. 8, no. 5, March 10, 1933, pp. 133–135. Widening causeway built on concrete bents from two lanes to four lanes of traffic; length is 16,430 ft.

SEWERAGE AND SEWAGE DISPOSAL

Activated Sludge. Mechanism of Activated Sludge Process, C. Lumb. *Surveyor*, vol. 83, no. 2143, Feb. 17, 1933, pp. 229–230; (discussion) vol. 83, no. 2144, Feb. 24, 1933, pp. 252 and 253. Cardinal points of activated sludge process; older theories; new theory of electric charges on sewage colloids, by Professor Baly. Before Inst. Sewage Purification.

Chemical Process. Development of Chemical Process for Treatment of Sewage, G. H. Gleason and A. C. Loonam. *Sewage Works Journal*, vol. 5, no. 1, Jan. 1933, pp. 61–73. Review of experimental work that led to development of the Guggenheim Brothers' process; character of influent sewage; sampling; equipment and materials; plant construction and expenditure; cost of operation.

Equipment. Mechanical Equipment in Sewage Treatment Works—VIII and IX, A. P. Folwell. *Pub. Works*, vol. 64, no. 2, Feb. 1933, pp. 18–20 and 28. Disposing of sludge; driers; centrifuges; sewage and sludge pumps; centrifugal pumps; reciprocating pumps; pneumatic ejectors.

Los Angeles, Calif. Completing Longest Continuous Gravity Sewer in United States, S. S. Ball. *Pub. Works*, vol. 64, no. 2, Feb. 1933, pp. 9, 10, and 41. Construction of concrete trunk sewer for the city of Los Angeles, Calif., which, combined with that previously laid, gives a continuous gravity line about 80 miles long; diameter varies from 18 to 57 in.

Michigan. Recommended Laboratory Methods of Analysis for Michigan Sewage Treatment Plants, E. F. Eldridge, F. R. Theroux, and W. L. Mallmann. *Mich. Eng. Experiment Station—Bul.*, no. 49, vol. 8, no. 2, Jan. 1933, 38 pp. Methods of chemical and bacteriological analysis for sewage treatment plants in Michigan; recommended method for keeping laboratory data; recommended methods for taking of samples; preparation of solutions.

New York. New York Sewage Works Association Discusses Sewage Works Financing. *Mun. Sanitation*, vol. 4, no. 2, Feb. 1933, pp. 53–55. Proceedings of the 1933 annual meeting of the New York State Sewage Works Association, including abstracts of papers and discussions on sewage financing, A. Wolman; Explosion and Health Hazards in Sewage Works Operation, G. W. Jones; Sewage Treatment Development, H. W. Taylor; Development of Chemical Process for Treatment of Sewage, G. H. Gleason; German sewage plants.

Ohio. Ohio Conference on Sewage Treatment, Fifth Annual Report, October, 1931. *Sewage Works Journal*, vol. 5, no. 1, Jan. 1933, pp. 196–201. Symposium consisting of the following papers: Operation of Akron Sewage Treatment Works, T. C. Schaetzle; Sludge Digestion—Theoretical Discussion, R. A. Allton; Discussion, F. W. Jones; Elyria Sewage Treatment Works, J. R. Collier; Trickling Filter Loadings, B. F. Hatch; Report of Investigation of Calcar Process of Treatment of Municipal Sewage at Circleville, F. H. Waring.

Operation. Experiences of Small Illinois City Prove Feasibility of One-Man Sewage Plant Operation, L. D. Suhr. *Mun. Sanitation*, vol. 4, no. 3, March 1933, pp. 80–83, 85, and 88. Practice of the City of Woodstock, Ill., with population of 5,500; description of plant equipment; analysis of aerator supernatant; sludge characteristics; test to determine degree of treatment.

Sewage Works Association. Meeting of New York State Sewage Works Association. *Water Works and Sewerage*, vol. 80, no. 2, Feb. 1933, pp. 47–52. Records of proceedings of 1933 Annual Meeting, including abstracts of following papers: Facts and Fancy in Sewerage Financing, A. Wolman; Explosion and Health Hazards in Sewage Works Operation, G. W. Jones; Development of Chemical Process of Sewage Treatment, G. H. Gleason.

Sludge. Interchange of Heat During Sludge Digestion, C. E. Keefer and H. Kratz. *Sewage Works Journal*, vol. 5, no. 1, Jan. 1933, pp. 3–16. Report on experiments conducted since December 1930, in laboratory at Baltimore sewage works to check the observations of Sierp and to study the temperature changes of sludge placed in calorimeters; computation of the quantity of heat absorbed and given off during digestion. Bibliography.

Trickling Filters. Reduction of Bacteria in Open and Closed Filters, A. A. Ormsby. *Pa. State College—Eng. Experiment Station Series—Bul.*, no. 41, May 1932, 21 pp. Continuation of investigation of comparative efficiency of open and closed trickling filters for the treatment of sewage, to determine reason for superiority of closed filter in bacterial reduction; evidence seems to indicate that most of the reduction is caused by the consumption of bacteria by protozoa which are found in the slime covering the stones.

Unemployment Relief, Sewer Construction. Saving Money for Public and Relieving Distress Through Sewer Construction by Unemployed, F. A. Barbour. *Mun. Sanitation*, vol. 4, no. 3, March 1933, pp. 84 and 85. Experience in Marblehead, Mass.; work on a basis of 24 hours a week; relative costs.

United States. Recent Progress in Sewage Treatment, G. W. Fuller. *Water Works and Sewerage*, vol. 80, no. 2, Feb. 1933, pp. 37–42. Chemical precipitation; intermediate degrees of treatment; sludge disposal methods; current trends in treatment processes.

STRUCTURAL ENGINEERING

Beams, Design. Additional Formulas for Beams Subjected to Axial and Lateral Loads, E. E. Blount. *Air Corps Information Cir.*, vol. 7, no. 665, June 15, 1932, 9 pp. Equations for some of the more common combinations of loading obtained by adding to the formula for one type of lateral load, load terms of formulas for other types to be combined with it.

Columns, Brick. Reinforced Brick Columns Tested at Lehigh University, I. Lyse. *Eng. News-Rec.*, vol. 110, no. 11, March 16, 1933, p. 345. Results of first series of tests, showing strength varying from 2,500 to 4,500 lb per sq in., reveal importance of vertical reinforcement, superiority of cement mortar and solid over-perforated brick, and advisability of using lateral ties.

Floors, Resilient. "Resilient" Flooring Materials. *Am. Arch.*, vol. 143, no. 2616, March 1933, pp. 89–95. Guide to the selection and use of rubber, cork, asphalt, wood fiber, and related synthetic composition floorings; factors influencing selection; point loads on resilient floorings; sub-floor requirements; tests for dampness in concrete sub-floors; thickness of resilient floorings; methods of installing resilient flooring materials.

Framed Structures. On Calculation of Stresses in Braced Frameworks, R. V. Southwell. *Roy. Soc.—Proc.*, Series A, vol. 139, N A 839, March 3, 1933, pp. 475–507. Theoretical mathematical discussion of computation of stresses in "simple" and "redundant" frameworks; "pseudo-redundant" frameworks; graphical and analytical methods; determination of stresses in tubular framework; special cases; satisfaction of imposed conditions at terminal bulkheads; general problem of loaded framework; theorem relating to pseudo-redundant frameworks.

Stresses. Stress Distribution in Wedges with Arbitrary Boundary Forces, J. H. A. Brahtz. *Physics*, vol. 4, no. 2, Feb. 1933, pp. 56–65. Stress distribution under plain strain in the corner of any angular magnitude; generalization of the method of von Karman, applicable to wedge, for any force distribution over straight boundaries; stress functions; stresses may be finite for certain continuous loadings but become infinite if portion of load is removed.

TUNNELS

Water Supply Tunnels, Chicago. Chicago Builds a New Tunnel to Carry Additional Water Supply from Lake Michigan. *Water Works Eng.*, vol. 86, no. 5, March 8, 1933, pp. 186–187, and 211. Description of the Chicago Avenue Lake and Land Tunnel, now in the process of construction; capacity 700 mgd; estimated cost $14,000,000.

WATER RESOURCES

Underground Supply, California. South Coastal Basin Investigation—Records of Ground-Water Levels at Wells. *State Calif.—Dept. Pub. Works—Division Water Resources—Bul.*, no. 39, 1932, 590 pp., supp. plates. Records of ground-water levels in southern California, including Santa Ana Valley, San Gabriel Valley, San Fernando Valley, West Coastal Plain, and Southern Coastal Plain from the Domingues Hills to the mesas of Orange County.

WATER TREATMENT

Activated Carbon. Activated Carbon in Industrial Water Purification, A. S. Behrman. *Water Works and Sewerage*, vol. 80, no. 2, Feb. 1933, pp. 55–59. Granular vs. powdered activated carbon; industrial water purification; field for activated carbon; removal of tastes and odors; clear water necessity with activated carbon purifiers; sterilizations; removal of organic matter and color; iron removal; life of activated carbon purifiers; Brandt patent. Bibliography.

Use of Activated Carbon in Water Purification, P. Smit. *Water and Water Eng.*, vol. 35, no. 414, Feb. 20, 1933, pp. 75 and 76. Illustrated examples from such practice. (Concluded.)

Flocculators. Mechanical Flocculators. *Water Works and Sewerage*, vol. 80, no. 2, Feb. 1933, pp. 43–46. Mixing for efficient results; coagulant to entrap practically all particles of mud, bacteria, etc.; mixing time; excess of coagulant; flocculator of Dorr Company; paddle diameter for various depths of water; advantages of flocculators; transverse flow type believed most efficient. Bibliography.

Great Britain. Burgh of Grangemough Water Supply. *Water and Water Eng.*, vol. 35, no. 414, Feb. 20, 1933, pp. 64–66. Review of the new filtration and chemical treatment plant having a capacity of 2,000,000 gal per 24 hours.

Ontario, Canada. New Water Purification and Pumping Plant at Hamilton, W. L. McFaul. *Can. Engr.*, vol. 64, no. 9, Feb. 28, 1933, pp. 15–19. Description of the recently completed water filtration plant of Hamilton, Ont., having a capacity of 40,000,000 imp. gal per day; details of chemical building and mixing chambers, twelve rapid sand filter units, wash-water tower, filtered water reservoir, chlorine house, connecting conduits, electric power, sewerage system, heating plant, and pipe tunnels.

Taste and Odor Removal. Bleaching Clay in Water Purification, G. D. Norcom. *Water Works and Sewerage*, vol. 80, no. 2, Feb. 1933, pp. 53 and 54. The Sanitary Engineer of the Federal Water Service Corporation, New York City, reports experience of water works of Chester, Pa., in the control of taste and odor by applications of powdered activated carbon and of bleaching clay.

WATER WORKS ENGINEERING

Cost Accounting. Model Water Department Cost Accounting System. *Pub. Works*, vol. 64, no. 2, Feb. 1933, pp. 37 and 39. Outline of cost accounting system comprehending all operations handled by public works and water departments, installed for the City of Newport, Ky.

Laws and Legislation. Recent Legal Decisons Which May Guide Water-Works Men in Avoiding Legal Entanglements, L. T. Parker. *Water Works Eng.*, vol. 86, no. 5, March 8, 1933, pp. 192–194. Questions involved in the taking of property without due process of law; legality of appropriation of water from stream; legal obligation of a city's indebtedness; diversion of surplus earnings of water department; validity of water statutes; public service establishes duty.

Water Distribution System, Gate Valves. Boston Water Department Uses Special Crew in Maintenance of Gate Valves, G. H. Finneran. *Water Works Eng.*, vol. 86, no. 4, Feb. 22, 1933, pp. 144–146. Method of locating gates; markings on valve box covers; details of procedure of checking, testing, and maintenance of gates; rare gate valve troubles. Before New England Water Works Ass'n.

Water Towers. Economy of Elevated Storage Strikingly Shown, D. H. Maxwell. *Water Works and Sewerage*, vol. 80, no. 2, Feb. 1933, pp. 63–65. Review of operating records of the Glencoe, Ill., water works furnishes a striking demonstration of the economy of elevated storage; pumping conditions with and without elevated tank on system; improved pressures; savings in power consumed; auxiliary equipment.

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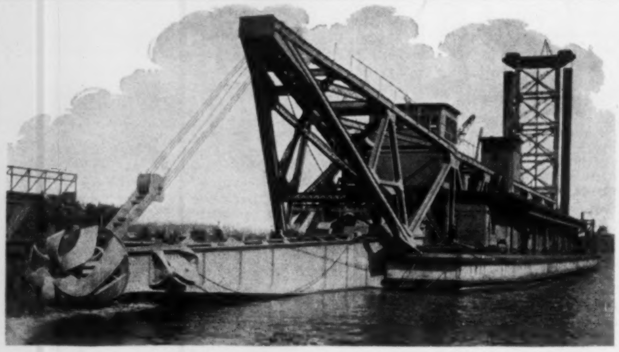

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